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Report of the

EXPERT CONSULTATION ON SELECTIVE SHRIMP TRAWLS

IJmuiden, The Netherlands, 12 - 14 June 1973

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1973

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PREPARATION OF THIS REPORT

This is the edited version of the Report of the Expert Consultation on Selective Shrimp Trawls, as adopted by the participants during the meeting held in Ijmuiden, The Netherlands, 12-14 June 1973.

Appendix I contains edited versions of the working papers submitted by the participants.

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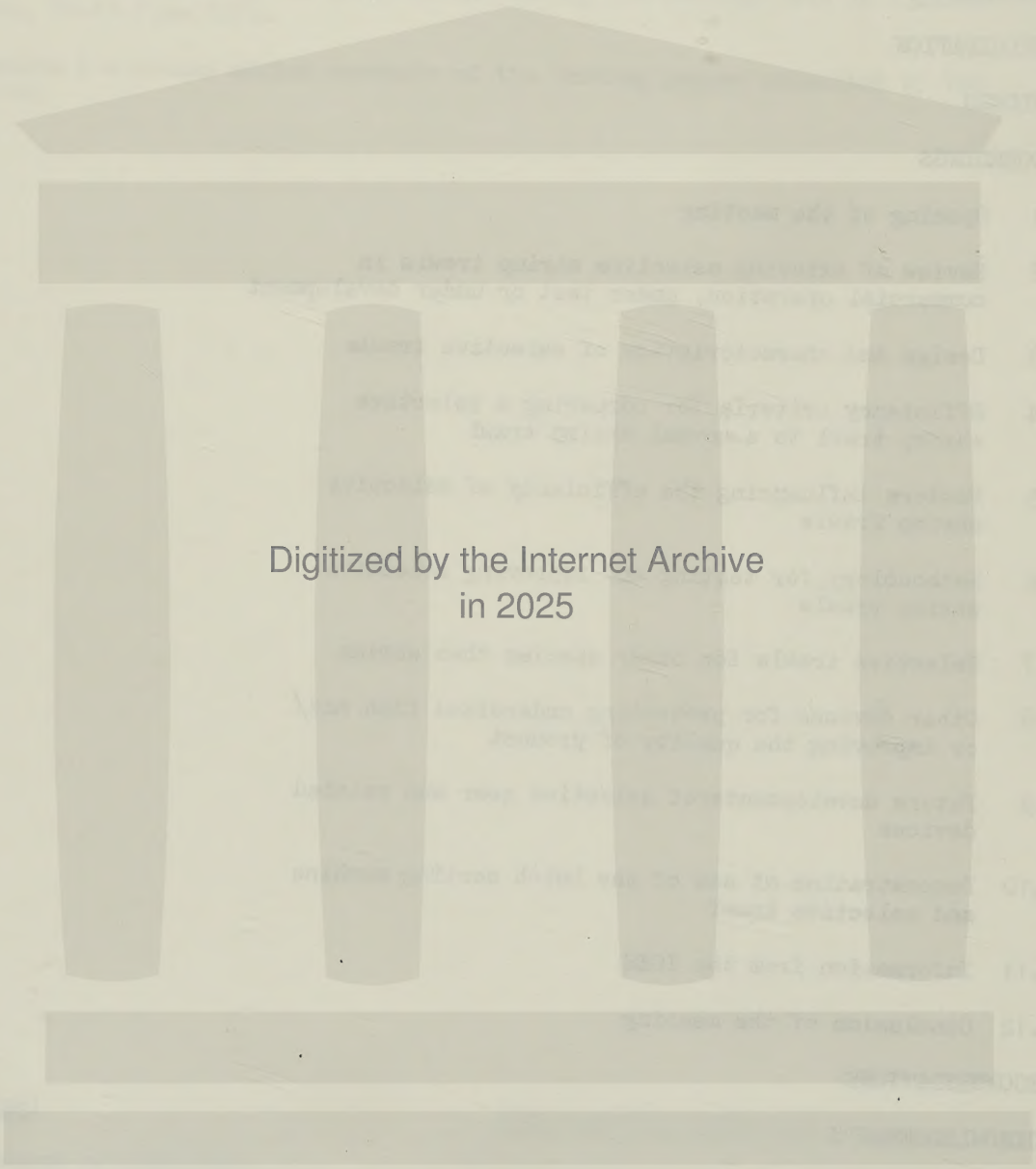

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1. BACKGROUND

The management of fisheries is faced with the continuously increasing effort on fish stocks, especially those exploited by trawling. To cope with this problem the protection of undersized or juvenile fish is one of the most effective regulatory measures that could be recommended. This is particularly true for the fisheries for shrimp which are now widely spreading throughout the world.

Selective trawls of different designs have been recently developed in several countries, such as France, Iceland, The Netherlands, Norway and U.S.A. The principle of these trawls is to allow the undersized flat and roundfish to escape without hampering the efficiency of the gear toward the commercial species sought. Incidentally, by reducing the sorting operation sometimes to almost nothing, a considerable amount of labour on deck can be saved, with in addition a consistent improvement of the product quality resulting from the reduced quantity of by-catch as well as from a much simplified sorting procedure.

The purposes of the Consultation were to prepare a comprehensive review and critical evaluation of the existing various types of selective trawls and other sorting systems for shrimp and other species; define the testing methodology and practical efficiency criteria for selective devices, their adaptation to various trawl types and fishing conditions and the possibilities and trends for future developments in this field.

2. ORGANIZATION

The participants were selected on the basis of their specialized knowledge and their designation received the agreement of the Member Governments concerned.

The Government of The Netherlands accepted to host the Consultation at The Netherlands Institute for Fisheries Investigations, IJmuiden. All necessary facilities, including secretarial support, were provided by this Institution.

Eight contributions were prepared by the participants of member countries especially engaged in testing and development of selective devices for shrimp. These contributions were presented and discussed during the sessions.

Following an agreement made prior to the meeting between the participants and FAO, the Consultation was conducted in English.

3. PARTICIPATION

The Consultation was attended by eleven experts representing seven countries, i.e., Belgium, France, Iceland, The Netherlands, Norway, U.K. and U.S.A.

A list of participants is given in Appendix III.

4. OFFICERS

Mr. J.G. de Wit, Deputy Director, Netherlands Institute for Fisheries Investigations, was elected Chairman of the meeting. Moreover, Mr. J.G. de Wit was designated by the Hosting Government as Liaison Officer for the Consultation.

Eight participants served as Rapporteurs for the various items of the agenda; their names are given under item 5 of this report (Proceedings).

Mr. C. Nédélec, FAO Fisheries Department, served as Technical Secretary for the Consultation.

5. PROCEEDINGS

5.1 Opening of the meeting

The Consultation was opened by an address delivered to the participants by Prof. Dr. P. Korringa, Director, Netherlands Institute for Fisheries Investigations.

5.2 Review of existing selective shrimp trawls in commercial operation, under test or under development

Rapporteur: Ian E. Ellis

5.2.1 General specifications of selective gear and summary of experiments

The problem of selectively capturing marketable shrimp is approached in a variety of ways:

Measures with standard trawls:

Norway Rollers or bobbins have been used along the footrope of a trawl, permitting the escape of juvenile flatfish while capturing shrimp. Meshsize regulations have been used to reduce the taking of smaller shrimp.

Iceland Shrimp are available in many areas. When the incidental catch of fish becomes great in an area, the fisherman moves to another nearby location. An important reduction of the amount of fish in the catch has been obtained in some areas by using shorter bridles.

U.K. A beam trawl used to capture Pandalus montagui has been modified to increase the vertical opening to about 1.8 m. This has increased the catch of shrimp without altering the fish catch providing a more favourable shrimp:fish ratio. Most beam trawls are fitted with groundrope rollers of 25 to 30 cm diameter to reduce the collection of rubbish.

U.S.A. The method of rigging a commercial net is often altered to reduce the by-catch of shrimp trawls. Adding floats or reducing weight raises the net and decreases catches of echinoderms, flatfish, Zoarcidae and Agonidae. Removing floats or adding weight can reduce the catch of Osmeridae, Engraulidae or Clupeid fish.

Specialized nets:

(a) Crangonid shrimp

Standard trawls for Crangonid shrimp have been modified by the addition of horizontal separating (sieve) panels to separate shrimp from fish. Such panels are attached with the front edge to the top of the net, sloping down and back, fastened to the sides of the net and terminating aft at the junction between upper codend and lower codend or trash chute.

France Selective trawl developments for Crangonid shrimp began in 1964 with nearly flat separating panels held down away from the top of the trawl by weights. Subsequent efforts have produced a more successful net having the separating panel held down by a narrow strip of net sewn in a V-shape (point forward) between the separating panel and belly of the net. In recent experiments 94.5 percent of the marketable shrimp were taken in the upper codend while only 36 percent by weight of the fish were in the upper codend. This 36 percent consisted primarily of small fish and constituted 65 percent of the number of fish taken.

Netherlands Experiments were begun in 1964 with nets similar to the French ones. Newer designs with the after end of the separating panel tapering into a tube have produced better experimental catch separation with less tendency to distortion by water pressure. The net provides a better quality catch than standard gear and reduces the hand-sorting effort required. It does pass some large shrimp out the trash chute, is subject to clogging by larger algae and does not satisfactorily protect juvenile flatfish.

Belgium A French or Dutch-style selective trawl was tested in shallow water Crangonid shrimp fishing in 1968. The net was quite successful, taking 72 to 97 percent of the marketable shrimp in the upper codend. Most of the fish went into the lower codend.

U.S.A. Tests were conducted with two nets patterned after a Dutch design published in 1965, but more than 50 percent of the fish catch were taken in the upper codend.

(b) Pandalid shrimp

Nets highly selective for Pandalid shrimp are being developed which, typically, have nearly vertical separating panels stretched across their mouths. Shrimp pass through into a shrimp codend while fish are allowed to escape over or under the panel or out through a trash chute.

U.S.A. Nets developed in a programme begun in 1968 have been highly selective for Pandalus jordani in the northeastern Pacific Ocean. The product has been of improved quality but the catch per hour has usually been lower than for standard nets. On some occasions nets have been used in the commercial fishery which have produced as many or more shrimp per day than competing standard nets. Experiments are continuing in an attempt to develop a highly selective net, simple to build and repair, and producing at a rate acceptable to the commercial fleet.

Norway The fishing experiments with selective shrimp trawls began in Norway in 1970, and up to 1973 experiments have been carried out mainly in the Barents Sea where fishery on Pandalus is expanding. The commercial shrimp trawls now used take great numbers of juvenile cod, haddock and redfish, and this unnecessary killing of young fish may endanger the stock of these commercial species. The same principle as for the American gear has been employed for trials with several different types of nets used in Norway. The larger Sputnik trawl has produced reduced catches when modified but the smaller wing trawl has made some good catches and the Kodiak trawl, when modified with lighter twine, has taken excellent catches with a high degree of selectivity.

Iceland A wing trawl similar to that used in Norway was tested but not successful due to excessively high drag for small boats. When satisfactory selectivity occurred, production rates were about 30 percent lower than for competing normal gear. Selective trawls are considered unnecessary in the southwest area where concentrations of pure shrimp are available.

5.2.2. Acceptance by commercial fishermen

Norway Although satisfactory results have been obtained with existing trawl designs, for commercial fishing the selective device must be simpler to build and repair, and the experimental work is continuing.

Netherlands The separating panel net was first introduced - on a small scale - into the commercial fleet in 1965. As response was not very encouraging, it was decided to have another try at it, this time on a wider scale. In 1967 an extended series of experimental fishing operations was carried out, simultaneously including comparative fishing and introduction of the new gear. The follow-up was slow, but from 1969 onward the separating panel became generally accepted in the northern "deep-water" (30-60 m) fleet. Use is restricted when large algae appear, as they will stick to the panel netting and thus clog the separator. The separating panel is manufactured as a standard product; it is relatively easy to fix onto the net and adjustments may be carried out in a short time.

U.S.A. Acceptance began in 1970 but has been reduced by a variety of problems, the principal objections being the complicated design which makes it difficult or impossible to obtain a good net and to repair damage. Very few nets are now in use and these are in the fisheries off Washington and Oregon only.

U.K. A few selective beam trawls are in use of Crangon crangon. Fishermen would probably be unwilling to adopt vertical separating panel nets in the Farn Deeps fishery for Pandalus borealis because they would not wish to lose the associated Nephrops.

France The use of selective gear will probably be recommended by the Government because of its superiority to standard gear for protecting immature fish, but it is not well accepted because of the difficulty of construction and repair of the type of net tested so far.

Belgium Selective trawls are not used commercially because the fishery occurs in shallow water in warm weather and algae clog the separating panel. The net is also too difficult to repair.

5.3 Design and characteristics of selective trawls

Rapporteur: G. Thorsteinsson

5.3.1 Gear with vertical separating panels

The basic idea about this construction is to cover the inner side of the net opening with a selective netting which allows the shrimp to go through to the codend but at the same time leads the by-catch to an escape route or trash chute. The first experiment with such gear was made in the U.S.A. In recent nets the separating panel was divided in two sections by a midline of the same length as footrope and headline. This feature was to keep the netting as vertical as possible. In the middle of the separating panel one or two chutes, through which the by-catch escapes, go out of the net, one through the lower panel and the second, if there is one, through the upper panel.

Wing trawls of this construction have been tried out in Norway and Iceland. In Norway short winged trawls [so-called "Sputnik trawl" and "Kodiak trawl" (semiballoon)] have also been tested.

In later experiments conducted in the U.S.A. the selective effect of these types of trawls has been improved by using three midlines instead of one, and the upper trash chute has been omitted.

In the U.S.A., shrimp trawl experiments have shown that the overhang (of the upper net) hardly influenced the shrimp catches, whereas the catches of pelagic fish were much higher by using an overhang. In the Norwegian experiments an overhang with large meshes was used, allowing most of the fish to escape even if no trash chute was mounted to the selective netting in the trawl opening.

In Iceland better catches were taken with an overhang.

In present experiments in the U.S.A. and Norway, a big meshed top and bottom ahead of the separating panel is expected to better keep the correct shape of the net. This should more effectively lead fish to the trash chute and reduce blockage of separating panel which may reduce shrimp catches.

The meshsize (stretched) of the separating net panel for Pandalid shrimp was 50 mm in the U.S.A. and 60 mm in Norway and Iceland. In all cases the shrimp are of comparable size with an average of 17-18 mm carapace length and a maximum of 23-24 mm. During the discussion it was pointed out that a small meshsize in trash chute was to be preferred.

5.3.2 Gear with horizontal separating panels

The idea behind this type of construction is to select the shrimp from the by-catch by using a slightly oblique or horizontal netting screen through which the shrimp jump to get caught in the small meshed upper codend, whereas the by-catch is supposed to swim under this panel into a bigger meshed lower codend. The front edge of the separating panel is sewn along the meshes of the upper net panel, then on the sides along the seams of the trawl, and finally at the back on the connexion between both codends.

As the water pressure will move the separating netting toward the upper panel of the trawl, some arrangement must be made to avoid this. In the first experiment carried out in France, leadlines were used for this purpose. This was also the case in the experiments made in the U.S.A., Belgium and Iceland. In France, with the newest trawl of this type, no leads are used any more. In order to keep the separating netting in a steady shape, a V-shaped netting piece of 15 meshes height is connected between the lower part of the net and the separating panel.

In France this type of net was used as an otter trawl, whereas in Belgium and The Netherlands the gear was a beam trawl.

In France the meshsize (stretched) of the separating panel was 50 mm against 60 mm in Belgium, in both cases for catching Crangon crangon. In the discussion it was pointed out that experiments with beam trawls in The Netherlands have shown that a meshsize below 60 mm in the separating panel results in a loss of big shrimp which are not in position to pass meshes below 60 mm. The total length of Crangon in these experiments was reported to be between 30 and 70 mm. It must also be kept in mind that the shape of the meshes is of importance too.

In Iceland an 80-mm separating panel was used on Pandalus borealis. Due to limited experimentation, no statement can be made yet as to the adequacy of this meshsize.

5.3.3 Selective effect of different parts of commercial trawls

It was noted that the effect on the shrimp catches of the many different lengths of sweeplines and bridles used is not well known. Short bridles might decrease the opening height of the net. In Iceland, inshore fishermen have decreased the by-catch of small fish about 50 percent by shortening the bridles from some 12.8 to 5.5 m, without any decrease in shrimp catches. On the open sea shorter bridles, however, resulted in a decrease in catch of shrimp and in particular of fish. Better results could possibly be obtained by putting extra weight on the wingends.

The influence of the length of the chains which connect the footrope with the groundrope was brought up. If using longer chains, the trawl will not catch so many bottom animals. A similar effect can be obtained by using bobbins which, on the other hand, allow the towing over rough ground thus yielding a variable catch composition due to different fauna.

It was reported that big meshes in the front part of the lower panel select some fish out of the trawl but relatively few shrimp. In Iceland big meshes are also used in this part of the net and in the lowest part of the wings to eliminate small flatfish. In addition to this a 60 cm long opening is frequently provided in the lower belly through which stones can pass.

5.4 Efficiency criteria for comparing a selective shrimp trawl to a normal shrimp trawl

Rapporteur: J.C. Brabant

5.4.1 Economic comparison

U.S.A. Although the drag of a selective trawl is greater than that of an ordinary one of comparable size, this system seems to be more economical. Fewer shrimp are caught per hour of fishing but sorting by hand is eliminated, the net may be towed for a greater number of hours and the catch per day may be as great as that of a standard net.

Netherlands In this country, the sorting problem is not so important and the selective trawl catches more shrimp if seaweeds are not too abundant. An ordinary trawl is often clogged by fish or jellyfish. As an example, during a day when jellyfish was very abundant, 50 kg of shrimp were caught with an ordinary trawl whereas a selective one caught 1 500 kg.

France An improvement of the quality is noticed with selective trawls. Live shrimp are more valuable.

U.S.A. Shrimp taken in a selective trawl are of a better quality and usually heavier than those taken by standard trawls, even if they are sometimes slightly smaller in size.

Norway It is only possible to compare two trawls fishing in the same area but not results from different areas due to varying growth and maturing rates in these northern waters.

5.4.2 Catch comparison

U.S.A. Periodically, samples from the catches of selective and ordinary trawls are taken and size distributions of captured shrimp are compared. Equipment is being developed to permit assessment of the fishing dimensions of the trawls so that nets to be compared may be made of equal size.

Iceland, Norway Size distribution of shrimp is the same in both selective and ordinary shrimp trawls.

France No difference either for shrimp but great difference in size distribution of fish from the two codends.

U.S.A. Composition of the catches is to be given by number and by weight.

Iceland For each fish species, it is recommended to give size distributions in the two codends, respectively, of the trawls to be compared.

U.K. To give the data by number is necessary. It is important not to underestimate the loss of small fish.

Norway A direct comparison between catches in various areas is rather difficult as they depend on the nature of fishing grounds, geographical position and meshsize in the codend.

5.5 Factors influencing the efficiency of selective shrimp trawls

Rapporteur: R. Boddeke

5.5.1 Nature of seabed

The nature of the seabed does greatly influence the catch of shrimp in general.

Trawl fisheries for Pandalids in Icelandic waters and along the U.S.A. northwest coast are typically conducted on soft bottoms. The net must then be adjusted in such a way that it stays just above the bottom.

A tickler-chain is usually used on the assumption that it will make shrimp, which would otherwise pass under the trawl, jump up into the path of the trawl.

Organisms

In using past models of selective trawls off the U.S.A. northwest coast, blocking of the separating panel by flatfish, seapens and basket stars has often been a problem. New net designs have been modified in an attempt to reduce this problem.

When many big flatfish occur in the sea, and especially large-sized jellyfish, the results obtained with selective trawls in The Netherlands are sometimes very much better than with ordinary trawls. Drifting seaweeds clogging the separating panel and the small jellyfish (Pleurobrachia), which pass easily through the wide meshes of the separating panel and fill up the codend(s), are a great handicap in Westem European waters for selective trawls.

In France, it was observed that in the case of a large amount of Pleurobrachia, 28 percent of the shrimp came into the lower codend and that the quality of the shrimp was bad, probably due to the irritating influence of this jellyfish.

5.5.2 The influence of the time of day on shrimp fisheries

General remarks on the behaviour of different species of shrimp were made. An interesting point was the pelagic behaviour of Pandalus borealis and Pandalus jordani during the night, making it difficult or impossible to catch them during darkness with a bottom trawl. This behaviour is the reason for the high opening of some Pandalus trawls, e.g., "Sputnik trawls". Therefore, it is advisable to design a trawl to meet the most common fishing circumstances.

Pandalus montagui in the Wash Bay, however, is sometimes better caught at night than by day for reasons yet unknown.

Net designs used in the northwestern U.S.A. must be appropriate to prevent by-catch of various fish species. A small mesh overhang ahead of the separating panel will increase the catch of smelt and herring. Incorrect use of the tickler-chain will increase the catch of flatfish.

5.6 Methodology for testing and improving selective shrimp trawls

Rapporteur: B. Rasmussen

5.6.1 Comparative fishing experiments

In the U.S.A. two nets have been used simultaneously (twin-trawl rigging): a trawl with a separating panel and an ordinary open trawl. This was considered the best way for comparing fishing ability under identical conditions. The two types of nets could be switched from side to side so that a number of hauls would give comparable results.

In Norway alternate hauls were used on the same day and same fishing ground, over several days and the results seemed quite consistent.

In The Netherlands two beam trawls were also fished simultaneously, but even this method could give faulty results, e.g., on narrow trenches, where one trawl was fishing deeper than the other. Useful experiments were therefore also made with alternate hauls.

It was generally agreed that it was difficult to introduce the selective trawl to the fishermen, whatever the results obtained. It was pointed out that any financial loss to the boat doing the experiments should be properly compensated which would increase the interest of the fishermen. A selective trawl, if successful, could also be given to a commercial boat for further trials (preferably with control on board).

5.6.2 Direct or indirect observations at sea

Direct observations of the selective shrimp trawl can be made by skin-divers. These divers should be gear specialists able to study the trawl configuration in detail underwater. The shape of the trawl can change with depth, and in deep water it might be necessary to use unmanned underwater photo devices. Indirect observations of the trawl opening may be done by means of netsonde or other acoustic techniques already developed for fish trawls.

5.6.3 Model tests

Model tests can be made in special tanks in order to study the general shape of the net and the separating panel. Models of larger size, i.e., at a reduction scale of 1/2 or 1/4, with full scale meshsize can be tested at sea. They give results which allow more accurate extrapolation to full scale and also include some behavioural aspect. Often such open water trials are cheaper than tank fish.

5.6.4 Behavioural studies

It is of importance to study the behaviour of fish and shrimp when designing a selective trawl. In Norway, experience has shown that in northern deep waters or murky weather, the shrimp stays high above the bottom, which necessitates a high opening of the trawl ("Sputnik trawl").

This makes the construction of a good selective trawl difficult as the separating panel will be subject to great pressure. In Iceland the behaviour of the deep-sea shrimp is similar, so that the selectivity problem is comparable. In the U.S.A., this problem has been partly solved by mounting additional intermediate lines across the separating panel.

The behaviour of the Pandalus jordani off the U.S.A. west coast has been assessed with special regard to the vertical distribution, which has proven to be variable, generally in association with variations in available light, although some variation has been observed without well defined reasons. Several other studies of value in developing selective trawls have been carried out by various means. Direct observation of fish and shrimp behaviour by scientist/divers has provided much valuable information. The capture, in small-meshed pouches on the exterior of a trawl, of shrimp and fish escaping through large meshes in a trawl, has helped to identify typical escape behaviour patterns.

In the U.K. fisheries, there are variations in catches of Pandalus and Crangon with slack water and tides. On the basis of experiments in the U.S.A. with a vertical shrimp sampler, it was suggested that this instrument could also give valuable information on the vertical distribution of other shrimp species.

5.7 Selective trawls for other species than shrimp

Rapporteur: P. Warren

5.7.1 Nephrops trawl

U.K. Around the U.K. there are valuable fisheries for Nephrops. Large quantities of whitefish by-catch normally accompany the Nephrops catch, but almost all the fish are killed when they are brought to the surface. There is a need for effective separation of Nephrops and whitefish at the seabed. The minimum meshsize for Nephrops trawl codends is normally the same as that for whitefish, i.e., 70 mm, but in one fishery the codend meshsize is reduced to 50 mm, to sustain commercial catches among a stock of small Nephrops. Experiments have been conducted with a trawl design to separate a mixed catch of Nephrops and whitefish by means of a horizontal panel through the codend, dividing it into upper and lower parts. The escape of small whitefish tends to be through the upper surface of a trawl and it has been shown that Nephrops pass through the meshes of belly or lower wings. In this experimental trawl the entire upper surface of the net was of 70 mm mesh and the lower surface was 50 mm. A panel of 50 mm mesh divided the codend and was attached to the centre bar of a large D-shaped metal hoop which was fitted in the net at the entrance to the codend. Experimental hauls showed that about 80 percent of Nephrops were retained in the lower codend and a majority of fish were present in the upper codend. Small whitefish escaped through the upper surface of the net. However, when the trawl was being hauled to the surface, Nephrops and fish in the body of the net went at random into either codend. There is some doubt whether the presence of a large D-shaped hoop would encourage commercial fishermen to adopt the trawl in its present form.

Iceland Net spread depends upon the trawl board size and smaller boards would limit spread and possibly reduce the escape of Nephrops through the wing meshes; if the net spread is too big, the footrope might also more easily pass over the Nephrops, thus decreasing the catch. The meshsize of Nephrops trawl codends has been increased to 80 mm and a further increase to 85 mm is under consideration.

U.K. The wing angle would be critical and when net spread is reduced, the wings might run parallel to the vessel's towing course. In this event, the wings would have no influence on the Nephrops catch and might inhibit the escape of fish sideways. There are some data which suggest an advantage in using a Gulf-of-Mexico flat trawl for Nephrops. When comparing a wing trawl with a smaller Gulf flat trawl of similar meshsize, it was found that the Gulf trawl took slightly less Pandalus borealis, but with a marked reduction in by-catch, while the number of Nephrops per hour more than doubled.

5.7.2 Smelt trawl

U.S.A. The smelt trawl took large quantities of smelt because these were the dominant species in the area at that time. So far, there is no evidence to suggest that smelt would be selected in a situation where another species was dominant.

5.7.3 Other

No discussions.

5.8 Other devices for protecting undersized fish and/or improving the quality of product

Rapporteur: E.J. De Boer

5.8.1 Rotary sieve

In The Netherlands the development of a rotating sorting machine for brown shrimp (Crangon crangon) was started in 1967 after the failure of introducing a selective trawl rigged with a separating panel at that time. Until 1967 the sorting of catch on board shrimp

trawlers was performed by a reciprocating riddle, having a speed of approximately 120 strokes per minute. This relatively high speed damages a large amount of undersized shrimp and flatfish which are caught unintentionally.

In order to increase the chance of survival of the undersized shrimp and flatfish, a rotating sorting machine was developed. This machine has two co-axial rotating sieves. The inner sieve separates the shrimp from the by-catch; the outer sieve gives a separation of consumable shrimp and undersized shrimp. The rotational speed of the machine is 16 rpm. To avoid damage during the sorting process, the surface of the sieves is kept very smooth; the material of the sieves is stainless steel. Furthermore, the catch is protected against damage and desiccation by supplying a great quantity of sea water. The inner sieve of the prototype machine had longitudinal slots of 47 x 12.5 mm. However, in practice although the machine sorted quite well its capacity proved insufficient. Next, the inner sieve was supplied with spiral slots which give an increasing capacity; some small flatfish, however, pass through the slots and the longitudinal transport is so fast that consumable shrimp are lost. This disadvantage could be solved by mounting a water jet at the end of the inner sieve to spirt the shrimp back. Big fish, jellyfish, etc. reach the end of the inner sieve and drop into a chute connected to a 25 cm diameter hose which goes overboard. A crew member standing at the end of the inner sieve can sample consumable fish.

The outer sieve is divided into two sections, one with longitudinal slots and one with spiral bars. In the former section the undersized shrimp fall through the slots and drop into a chute which also ends into the discharge hose. The consumable shrimp reach the latter section and fall into a collecting basket.

Summarizing, the rotating sorting machine has three separated outlets: by-catch, undersized shrimp, and consumable shrimp.

Besides the asset in conservation of the stocks of both shrimp and flatfish this machine has the following advantages for the fishermen:

- mud and sand are washed off, resulting in a very clean catch;

- almost no handsorting is necessary, resulting in considerable savings in labour;

- the sieves can be replaced within a few minutes, e.g., by sieves with larger slots.

It can be stated that the rotating sorting machine is accepted by the Dutch shrimp fisheries, although this acceptance mainly results from Governmental financial support.

The last development is an automatic feeding system for the rotating sorting machine. The catch is dumped into two collecting hoppers with overhead water jets. From the hoppers, the catch is regularly transported to the input opening of the rotating sorting machine by means of a conveyor belt. Besides a saving of labour, this system prevents the catch from lying on an open deck exposed to the sun and improves the sorting performance of the machine as feeding is uniform.

In the U.K. the rotating sorting machine has undergone trials with the shrimp species Crangon, Pandalus montagui and Pandalus borealis. It was stated that the machine performed very well and delivered a product of good quality.

Remarks were made that, from the point of view of stock preservation this machine is only suitable for fisheries in shallow waters; in Iceland and Norway, for instance, the fish is caught at great depths and dead fish of commercial value comes on board; selective trawls are necessary under these circumstances.

In Iceland, experiments were performed with two types of sorting machines for P. borealis. These experiments have been successful; the fishermen have, however, several objections: the machines are too expensive; they cannot be used in bad weather and at the end of long hauls the shrimp and fish are already dead in the codend.

It was observed that in the tropics, the shrimp fishery is mostly in relatively shallow water. It is therefore considered worthwile encouraging the development of a rotating sorting machine suitable for the various species of tropical shrimp.

5.8.2 Use of stimuli

In The Netherlands, research is carried out on the use of electric pulses in both the shrimp and flatfish trawling. Three types of pulse generators of different configuration are available for these tests. Two of the generators give a pulse created by the discharge of capacitors, the third generates block pulses. In shrimp trawling, the electric stimuli are used in order to reduce the differences in the catch during night and day. Attempts to stimulate only the consumable shrimp leaving the undersized shrimp and flatfish undisturbed failed until now. The electric pulses used in flatfish trawling are an attempt to replace the heavy tickler-chains in use nowadays by an electrode array and to stimulate only marketable flatfish. Research in this field has started rather recently, and the trials carried out so far indicate that a lot of work is still required in order to obtain results which can also be used by commercial fishing vessels. Questions were put forward about the application of light and acoustics as stimuli, but no information was available.

5.9 Future developments of selective gear and related devices

Rapporteur: H. C. Besançon

5.9.1 Offshore fishing for shrimp

It may be considered a fact that fish hauled to the surface from depths of 55 m or more have no chance of surviving, even in the case that they are brought back in the sea promptly. Consequently there is a need for selective fishing gear.

Apart from the bottom trawling techniques which have been under discussion so far, midwater trawling techniques have also to be considered. In some countries experimental midwater trawling for shrimp has been conducted or is at present under way. Other countries have some experience on shrimp by-catches in midwater trawls for fish. Deep-scattering layers may become of interest with regard to "shrimp" (crustaceans).

Though a little outside the scope of the meeting, a short discussion on krill fishing revealed that:

- fishing for krill does not present basic technical problems such as to make it unfeasible;
- krill appears in dense concentrations of isolated populations, so that there seems to be no necessity for selective measures;
- Norway has a small scale krill fishery, the catch being used for salmon and trout rearing; the U.S.S.R. and Japan are active in development work.
- since krill represents a large latent source for protein substantial and accelerating development in production can be envisaged.

5.9.2 Tropical shrimp fisheries

Shrimp trawling in tropical waters is mainly for Penaeid shrimp which behave similarly to the brown shrimp in European waters.

It is predominantly a shallow-water operation, so that the same problems are encountered, i.e., catching and subsequent killing of juvenile and/or small-sized mature fish.

An exchange of experience gained in developing countries highlighted the following facts:

- Problems created by local fishermen and those caused by the (generally foreign-owned) fleets of modern shrimp trawlers that exploit the fishing grounds without being too concerned about stock conservation, require a different approach:

- the use of more sophisticated devices like the rotating sieve and separating panels in trawls (or show nets) might have an adverse effect on food habits and the employment situation of local small-scale fishermen;

- for larger shrimp trawlers, however, this kind of equipment might be equally suitable as elsewhere to restrict the damage to stocks;

- the protection of juvenile fish should be differentiated from the separation of shrimp from small-sized mature fish which are often accepted as food at local markets;

- consequently the promotion of techniques which proved their value in industrial-type fisheries for developing tropical fisheries must take the specific and complex conditions into full acount.

5.10 Demonstration at sea of the Dutch sorting machine and selective trawl

During the last day of the meeting a short trip at sea on board a Dutch shrimp trawler was organized by the hosting Institute for demonstration of the Dutch sorting machine and the selective trawl for brown shrimp (Crangon).

All participants attended this demonstration which was conducted on a double rig shrimp trawler (19 m long and 240 hp) operating two beam trawls simultaneously, a normal trawl on one side and a selective trawl on the other side. This provided easy comparison of the catches made with the two different gear. The deck installed sorting machine was combined with two water tanks for keeping the catch after emptying the codend in good condition. The sorting machine was fed by means of an hand-driven elevator in each tank. With this arrangement the sorting of the catch and the release back into the sea of undersized fish and shrimp is entirely automatic. As a consequence, the crew consisted of only three man.

5.11 Information from the ICES

As Chairman of the Gear and Behaviour Committee of the International Council for the Exploration of the Sea (ICES), the Chairman of the Consultation, Mr. J.G. de Wit, briefly informed the participants of the work which is currently carried out by this international institution. In particular he mentioned the set-up of specialized working groups, the task of which is to provide up-to-date information and to prepare technical reports or manuals. These working groups are dealing in particular with the following subjects:

- research and engineering aspects of fishing gear, vessels and equipment (Mr. J.G.de Wit is also convener of this group);

- methods and results of experiments on fish reactivity in relation to fish capture;

- data collection and processing in fish capture research;

- standardization of scientific methods for comparing the catching performance of different fishing gear;

- research on sound and vibrations in relation to fish capture.

Some other fields of study, such as the effect on the seabed of bottom trawls, particularly of groundropes and tickler-chains, were also mentioned.

Considering the close relation existing between some of these studies and the purposes of the meeting, it was agreed that the conclusions and recommendations of the FAO Consultation be made known to the ICES, in particular on the occasion of the next meeting of the Gear and Behaviour Committee.

5.12 Conclusion of the meeting

The Consultation was concluded by the adoption by the participants of the rapporteurs' reports (items 5.2 to 5.9) and the recommendations (item 6).

6. RECOMMENDATIONS

- Most shrimp fisheries of the world capture and kill large quantities of unmarketable fish, including in many cases juveniles of economically important species. It is recommended that fisheries research activities be directed to the design and improvement of selective shrimp trawls to reduce the serious damage occurring to certain important fish species.

- If selective shrimp trawls appear to be capable of capturing shrimp at a commercially acceptable rate while effectively safeguarding unwanted fish, it is recommended to support the introduction of such trawls, in particular by providing instructions to the shrimp fishermen on the construction, operation and repair of these gears.

- When evaluating the effectiveness of a selective shrimp trawl, it is recommended that attention be paid both to the conservation aspect and to economic considerations including labour saving, improvement of product quality and production capability on a long-term rather than on a catch-per-hour basis.

- When reporting on the results of selective shrimp trawl tests, it is recommended that the data be presented in an uniform way to permit comparison with other experiments. In particular, data reported should include for both the experimental and control trawls:

  the specifications of the nets and accessories;

  the fishing configuration (dimensions of the trawls);

  the total weight of the shrimp catch and of the by-catch;

  the length and weight composition of the shrimp and the by-catch species.

- When conducting comparative fishing experiments to evaluate the efficiency of a selective shrimp trawl, it is recommended to operate, whenever possible, the two gears simultaneously, i.e., by using a twin trawl system with one pair of warps and one pair of trawl boards, or a double rig with each gear towed by a single warp and its own set of trawl boards.

- If a new type of selective shrimp trawl is to be designed for a given area, it is recommended to make preliminary studies of the vertical distribution of the various species of shrimp and fish in relation to environmental factors and to identify the behaviour patterns of the various species which would be useful for separating them from one another.

- Considering the proven efficiency of the rotating sieve developed for Crangon, in particular with regard to the protection of undersized fish and shrimp in shallow water fisheries, it is recommended that similar devices be evaluated, adapted and introduced in other shrimp fisheries.

- In many tropical areas competition exists between the indigenous artisanal fisheries and newly developing fisheries for Penaeid shrimp by modern trawlers. It is recommended that the use of selective trawls and sorting machines on board the large industrial Penaeid-shrimp trawlers be stimulated to protect undersized shrimp and small fish, to obtain the highest possible yield of the total fisheries in a certain area.

7. ACKNOWLEDGEMENTS

The Organization wishes to express its thanks to the Government of The Netherlands for hosting the Consultation and providing all required personnel services and facilities through The Netherlands Institute for Fisheries Investigations, IJmuiden.

The reception offered by and the hospitality of this Institute were particularly appreciated by the participants.

APPENDIX I

Contributions presented at the Consultation

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DEVELOPMENTS IN THE DUTCH SHRIMP (Crangon crangon) FISHERIES

by

R. Boddeke

INTRODUCTION

During the last ten years the problem of the by-catch of undersized flatfish has played an important role in Dutch fisheries research. Shrimp fishing is carried out with relatively small-meshed trawls. Inevitably many small fish are caught with the shrimp. Especially in The Netherlands the problem of the by-catch was very serious. The shallow coastal waters along the Dutch coast are main nursery grounds for valuable flatfish like plaice and sole. Both species are much more important for the Dutch fisheries than the brown shrimp (Crangon crangon). In 1972 the contribution of shrimp to the total yield of the Dutch sea fisheries was only 4.6 percent, for sole it was 34.5 percent and for plaice 14.5 percent. An extensive research on the damage of shrimp trawling to the stocks of juvenile flatfish in 1963 and 1964 gave the following results: in that period more than 1 000 million small plaice; 400 million small dab and about 100 million small sole were killed annually. Additionally, about 20 000 million small shrimp (used for the production of chicken feed) were landed annually. This number was four times higher than the number of landed consumption shrimp but the undersized shrimp added less than 5 percent to the financial output of the shrimp fishery.

It is quite clear that a fishery which is so destructive to other much more important fisheries has, in fact, no right to exist. For this reason it was tried in The Netherlands to solve the problem of the by-catch without prohibiting shrimp fishing.

SELECTIVE TRAWL

The first step to solve the by-catch problem was the introduction of a selective trawl for brown shrimp, improved after an original French design. The Dutch version was a normal Dutch beamtrawl net provided with a separating panel of wide meshes (48 mm meshsize stretched) fixed at some distance from the mouth of the trawl to the upper panel and along the lateral sides of the belly of the trawl. The shrimp pass through the meshes of this "sieve" and are caught in the codend. The by-catch which does not pass through the separating panel escapes through a hole in the lower belly of the trawl just in front of the point where the separating panel is fixed to the lower panel of the trawl.

During a long series of experiments in 1963 and 1964 the results obtained with this trawl were very satisfactory, although it became clear that its vulnerability to drifting seaweed clogging the separating panel and preventing the shrimp to reach the codend was an important disadvantage. However, if no drifting seaweed occur, this selective net catches considerably more consumption shrimp than a normal trawl. The advantage increased with the amount of by-catch, from 9 percent in very clean fishing to more than 100 percent when large amounts of jellyfish occur. The increase in catch is caused by the avoidance of large amounts of flatfish in the codend of the selective trawl. When a trawl codend becomes clogged by the catch, countercurrents occur which have an adverse effect on the further increase of the catch. An additional advantage of the selective trawl was the much better selection in size of the shrimp in the codend, compared with a normal shrimp trawl. In clean fishing, the amount of undersized shrimp caught with the selective trawl was up to 39 percent less than with a normal trawl. This percentage was lower when larger numbers of small flatfish entered the codend of the selective trawl.

In spite of its considerable advantages, this selective trawl was not adopted generally by commercial shrimp fishermen, but used only in periods when large amounts of jellyfish occurred.

After 1964 the Dutch shrimp fishery changed gradually from inshore or coastal fishing to high-sea fishing, especially in the northern part of the country. In the high sea, seaweeds do not cause any problems. This change in the character of the shrimp fishery made possible the sudden commercial success of the selective trawl in 1969. A slightly different type of separating device (with a conical separating panel of 60 mm meshsize stretched) is now used by practically the whole shrimp fleet in the northern part of the country (106 ships). In the south of the country selective trawls are still not in use. The fishing boats operate mainly in inshore waters or very close to the coast and the by-catch of eel and flatfish is of great importance for the economy of the southern fishery.

SORTING MACHINE

The slow introduction of the selective trawl made it necessary to look for other methods to solve the by-catch problem of shrimp trawlers. In 1967 the construction of a new type of shrimp sieve began in cooperation with a machine factory in Colijnsplaat to replace the primitive shaking sieve then in general use in the Dutch fleet. This shaking sieve consists of two flat sieves one above the other which move simultaneously with a frequency of 100-200 "beats" per minute. After sieving, the flatfish in the catch are often dead or fatally wounded by the beats of the sieve, the shrimp are often mixed with mud and slime and the sieve is often clogged by seaweed, Gobius (small fish species) and hydroid polyps.

The new rotating sieve (see also contribution by Besançon, Fig. 2) has two co-axial seive cylinders, constructed of very smooth stainless-steel bars, rotating with 15 rpm. In the inner cylinder the by-catch is separated from the shrimp; in the outer cylinder consumption shrimp are separated from the undersized shrimp. The sorting process requires a sufficient amount of seawater flow in the machine. An intricate system of tubes and valves brings the water to the places where it is needed for the sorting process. A pump of 5-6 cm diam is necessary to provide a sufficient water supply under all circumstances.

To separate the shrimp from the by-catch, two types of inner cylinders are in use. The first type is made of straight round bars of stainless steel of 9 or 12 mm diam. The spacing between these bars is 12.5 mm. Circular stainless-steel threads of 1 mm diam fixed inside the cylinder divide the spaces into slots of 12.5 x 47.0 mm opening. Shrimp move in the machine with their backs first. When they come between two threads they are led by the threads to the sieve openings (slots) and fall through because their centre of gravity lies in the backpart. Fish move in the rotating cylinder heads first and most of them pass over the slots.

With this type of sieve it is even possible to separate sharply shrimp from fish of the same size and about the same form, e.g., Gobius. It thus provides a very good separation of shrimp out of the catch and gives excellent results with by-catch consisting of great amounts of "tangling" animals (e.g., crabs, various species of starfish and hydroid polyps).

The other type of inner sieve has the stainless-steel bars of 9 mm diam arranged in spiral form with a spacing between of 12 mm. The slots of 37 mm lengths are formed by stainless-steel rings, also made of 9 mm diam rods and fixed at the outside. The inner surface of this sieve is much smoother than of the other type.

For the protection of small flatfish, this type of sieve is preferable. An additional advantage is that the passage of the catch through the sieve cylinder goes much quicker, so the capacity of the sorting machine is bigger.

Disadvantages are that the passage of small fish through the sieve openings is easier and precautionary measures must also be taken to avoid shrimp getting lost by coming out of the sieve together with the by-catch. This is done by a seawater spray at the end of the sieve spouting back the shrimp into the sieve, while the heavier by-catch passes.

The preference of the fishermen for the second type of inner sieve has had an influence on the construction of the outer sieve, which formerly consisted of straight bars only. It now consists of a section of straight bars with a spacing of 6.88 mm followed by a section with spiral bars with a spacing of 6.5 mm. This change in the direction of the slots is highly effective for the size selection of shrimp and the removal of small fish from the consumption shrimp.

Finally, the consumption shrimp enter a final wider spaced (12.5 mm) spiral section of the outer sieve. They easily fall through the slots of this section into a basket placed below. The flatfish which have remained unsorted so far enter this section heads first and get a solid grip on the bars with their "side" fins. They move along the spiral bars with the rotations of the sieve and fall finally into a chute together with the other by-catch from both sieves. From there the whole by-catch, including undersized shrimp, is swept overboard through a wide tube by an ample amount of seawater.

Crangon crangon is a sturdy animal, not very easily damaged by mechanical influences. The most important threat to small shrimp is **desiccation** of the gills in dry air. Because the selection process in the sorting machine takes place in seawater, the small shrimp stay fully alive.

Thanks to the smooth surface of the sieve, the great amount of water, and the slow revolutions, undersized flatfish like plaice and sole, also stay in perfect condition.

A tagging experiment with plaice carried out in 1967 with the first type of inner sieve (with circular steel threads on the inner surface) gave the following results:

(a) plaice taken out of the net (522 specimens);
(b) plaice which passed through the rotating sieve (542 specimens);
(c) plaice sieved through a shaking sieve (550 specimens).

Fish liberated were recaptured at the rates of 20.3, 19.0 and 8.2 percent, respectively.

The new type of sorting machine with the smoother inner sieve cylinder protects flatfish better but the results of recent tagging experiments are not yet known.

AUTOMATIC TRANSPORT

Recently an automatic transport of the catch to the sorting machine passed a series of tests with fully satisfactory results. The commercial model of this automatic transporter is under construction now. The great advantages of this automatic transporter are:

(1) the catch is not dumped on deck anymore but into basins with seawater;
(2) the catch is thus kept wet during the complete stay on board;
(3) the sorting process is faster and more regular and the chances of damage to fish are even smaller.

GOVERNMENTAL MEASURES

The use of the rotating sieve and the automatic transporter in commercial fishing are stimulated by financial contributions of the Government. The governmental contribution for the complete outfit is 43 percent of the factory price.

INTRODUCTION OF THE MACHINE

At the moment, about 60 percent of all Dutch shrimp trawlers are using the sorting machine.

It is noteworthy that, in the southern harbour of Colijnsplaat where no selective trawls are used, only one ship out of 12 does not use the sorting machine.

COMMERCIAL ASPECTS OF THE SORTING MACHINE

The reasons, by professional fishermen, for using the sorting machine are:

(a) better sorting of the catch resulting in more shrimp from every haul;
(b) size selection of shrimp by the outer sieve is considerably more accurate than the selection by the shaking sieve;
(c) the selection process in water gives more lively and cleaner consumption shrimp, resulting in a better quality of the final product;
(d) consequently and especially under difficult fishing conditions, the financial yield is increased considerably by using a sorting machine instead of a shaking sieve.

In comparative experiments a financial advantage of about 30 percent was observed several times.

LANDINGS OF UNDERSIZED SHRIMP

Landings of undersized shrimp dropped gradually from 1963 to 1971. In that year, the Ministry of Agriculture and Fisheries bought out the last big shrimp-drier. Since then, the problem of fishing for undersized shrimp does not exist anymore.

RESULTS

All developments mentioned above, and the change in character of the shrimp fisheries, has brought down very considerably the damage done by the Dutch shrimp fleet to the stocks of valuable flatfish. Research carried out by Dijkema of The Netherlands Institute for Fishery Investigations gave the following figures for undersized flatfish killed in 1972 by the Dutch shrimp fleet: sole 1 million; plaice 64 million; dab 20 million.

It must be kept in mind that year classes of these three species were much smaller in 1972 than in 1964. But, even when this is taken into account, the progress made in The Netherlands in this field is unmistakable.

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REVIEW OF THE DEVELOPMENT OF THE SELECTIVE SHRIMP TRAWL IN THE NETHERLANDS

by

H.C. Besançon

Double rig shrimp trawling in The Netherlands is accompanied by a number of problems concerning:

(a) the by-catch of juvenile shrimp;
(b) the by-catch of juvenile fish, especially flatfish;
(c) the adverse effect on the shrimp catch by jellyfish, crabs, shells, several species of small fish, weeds, debris, etc.

The effects of the by-catch are:

- destruction of immature shrimp that - given the chance - could have grown within a few months to marketable size. This, in fact, is an example of irrational exploitation;

- destruction of immature sole, plaice and other species that - given the chance - could have grown into marketable fish, the selling value of which would have been considerably higher than that of the shrimp landed;

- sorting and cleaning of the shrimp catch becomes laborious and time-consuming, thus hampering the production process.

For adoption by the Dutch shrimp fishers the originally French idea of fixing a separating panel inside the trawl had to be adapted to the specific characteristics of the beam-trawl. Technical trials were conducted to investigate the effects of the dimensions and the inclination of the separating panel, the meshsize, materials used and the dimensions of the discharge hole in the belly.

Simultaneously, an attempt was made to obtain visual information on the gear and on the shrimp behaviour in relation to the gear by attaching an underwater TV camera on the beam. Due to the fact that the camera could not be aligned properly, this attempt had to be abandoned at an early stage.

In 1967, an extensive series of comparative trials was conducted using commercial boats and covering all the grounds fished by the Dutch shrimp trawlers. The aim was to convince the skippers of the usefulness of the selective trawl and, at the same time, to evaluate the effectiveness of the separating panel under commercial fishing conditions.

Two types of separating panels were used:

- the flat one, consisting in a single piece of netting the forward edge of which is fixed to the first or second section of the upper panel of the trawl; the aft edge is sewn to the aft side of the discharge hole. At the sides and in the middle a lead selvedge was attached in order to keep the separating panel away from the upper panel of the trawl;

- the semi-circular one, consisting in a single piece of netting the front edge of which is fixed to the trawl in the same way as for the flat one; the aft edge is sewn around the discharge hole. Part of the side edges are sewn to the belly of the trawl in such a way that the separating panel forms a funnel just in front of the discharge hole.

Experience gained during the trial period may be summarized as follows:

- shrimp caught in the net with separating panel are of far better quality than those caught in the ordinary net. This could be due to the fact that, during trawling with a separating panel, the catch is kept cleaner of bottom trash, sand, etc., and is continually being washed;

- shrimp of consumable size get lost through the discharge opening in the belly of the selective trawl in largely variable quantities. It is noteworthy that this loss includes particularly large and very large size specimens;

- clogging by seaweed (Ulva) and hydroid polyps causes a strong decline in catches (down to zero in some cases). Therefore, the use of the selective trawl is strictly limited by the presence of such. In such conditions, the use of the ordinary trawl is indicated because it catches at least some shrimp even if the trash and other by-catch with its adverse effect has to be accepted;

- rigging of the separating panel inside the net requires accuracy, calling for a specialist netmaker or fisherman with a thorough knowledge of net rigging. The separating panel must neither be too sloppy because this could lead to undulations, nor too tightly stretched which would cause deformation of the net. If it should be necessary to adjust the rigging, at least half an hour will be needed to correct minor defects and up to three hours for more serious faults;

- optimum protection of young undersized flatfish and simultaneously optimum catching efficiency for shrimp are actually not compatible. Small meshsize in the separating panel protects the flatfish but reduces shrimp catches. Increasing the meshsize from 45-70 mm stretched - as has been done during the experiments - caused an increase of shrimp catches but, at the same time, also of the number of undersized flatfish caught;

- periodically immense quantities of crabs (Portunus) are present on the Dutch shrimp grounds. The use of a separating panel with small meshes (45 mm meshsize stretched) resulted in the decrease by 60 percent of the number of crabs mixed with the consumable shrimp, after sorting by the ordinary shaking sieve. The subsequent cleaning of the cooked catch, which is done by hand, is thus considerably facilitated.

Follow-up by the fishermen has been very slow. Only in 1969, the selection trawl became generally accepted in the northern fleet which works the deeper fishing grounds north of The Netherlands (30-60 m water depth). The separating device used now consists actually of two equal pieces of netting sewn together in such a way that a funnel is formed (Fig. 1). The forward edge of this funnel is sewn to the trawl net, the aft edge is sewn around the discharge hole. This separating panel is manufactured as a standard product.

In the years 1965 to 1970, a rotating sorting and washing machine (Fig. 2) has been developed which has proved to be a good means to protect immature shrimp and flatfish from destruction. The purpose of this machine is:

- separate trash and fish from the shrimp catch and to return the former straight back to the sea using water as a means of transport.

- separate undersized shrimp and small flatfish from the consumable shrimp and return the former alive back to sea, again using water as means of transport;

- wash the consumable shrimp thoroughly, to gain a high quality product;

- mechanize handling of catches for reducing hand labour and thus manpower requirements and increase efficiency.

General opinion on the separating panel inside the shrimp trawl is as follows:

- it helps considerably in preventing bottom trash and jellyfish from mixing with the shrimp and so assists in gaining a better quality product;

- though the construction of the separating panel has been improved considerably, it remains vulnerable to damage by debris, etc. A constant check on the correct rigging is necessary. The installation of the panel inside the trawl is quite simple, repair time is short;

- the separating panel is not the full answer to problems concerning shrimp stock conservation. Fishermen actually use the panel for its sorting capacity and consequent increase in overall efficiency;

- the rotating sorting and washing machine has proved to be more effective for the conservation of undersized fish and shrimp;

- the combined use of the separating panel and the rotating sorting and washing machine will most likely provide optimum results.

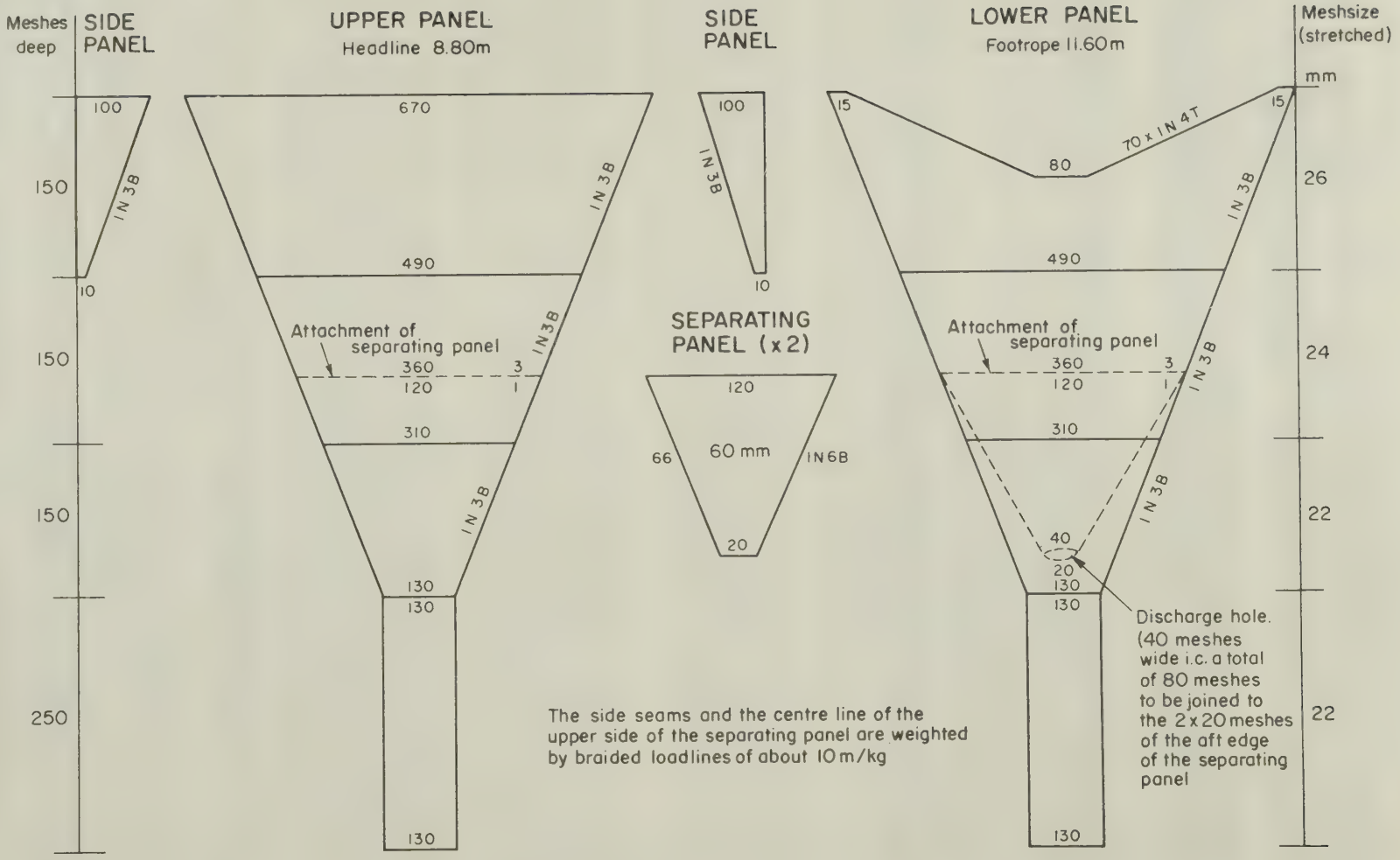

Fig. 1 9 m beam trawl with funnel-shaped separating panel

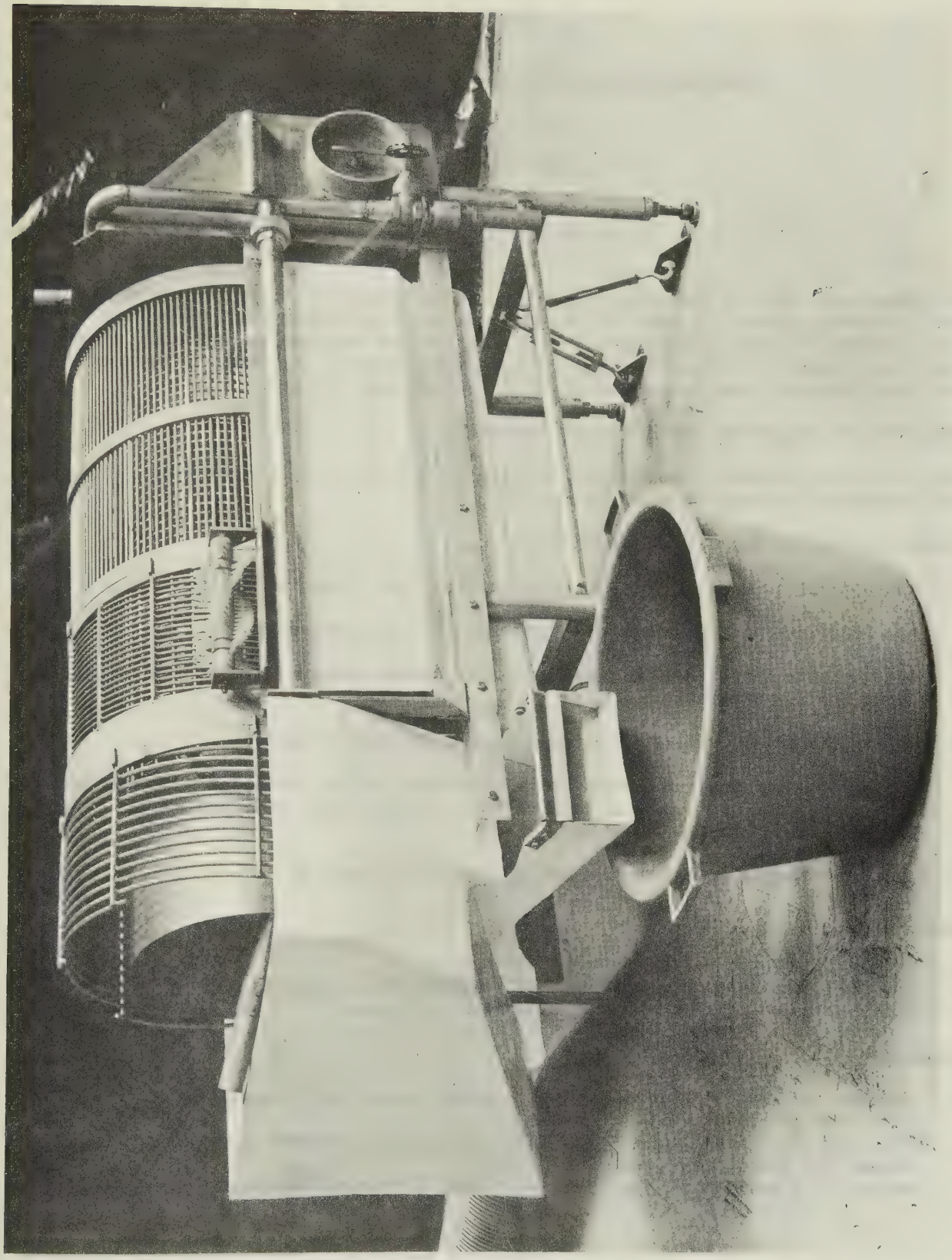

Fig. 2 The Dutch rotating sorting and washing machine for shrimp trawl catches

EXPERIMENTS WITH A SELECTIVE SHRIMP TRAWL

by

G. van den Broucke

and

A. van Middelem

The trials were carried out along the Belgian coast aboard a shrimp trawler of 240 hp. The sieve (separating panel) is made of larger meshed netting and divides the net into two parts with separate codends. The upper codend with smaller meshsize retains only those shrimp and fish which have passed through the separating panel. The rest of the catch (and by-catch) goes into the lower codend which is of conventional design.

CHARACTERISTICS OF THE SHRIMP TRAWL FOR AN 8 m BEAM

Fig. 1 gives a schematic longitudinal section of the selective trawl tested. The construction drawing of the net is given in Fig. 2.

Characteristics of the net are as follows:

- the netting is made of polyamide yarn of R530 tex, R640 tex and R740 tex;
- the headline and groundrope are 7, 8 and 10 m long respectively;
- the meshsize (stretched) of the net itself varies between 26 mm and 18 mm and is 60 mm for the separating panel;
- the meshes of the separating panel are mounted in N direction;
- the separating panel is fitted along the centre with a number of small sinkers (pieces of lead) in order to keep it off the upper panel and thus secure a more efficient selectivity.

The selection results of the trials are summarized in Table 1.

Advantages:

- processing of the shrimp catch is faster;
- the separated catch (two codends) is less subject to damage;
- there is a possibility of protecting small species.

Disadvantages:

- in case of damage to the net and separating panel, more time is needed for repairs than with ordinary nets;
- the lower (ordinary) codend generally contains the largest shrimp; omitting this codend can lead to big losses;
- during some periods (bloom) the selectivity decreases considerably.

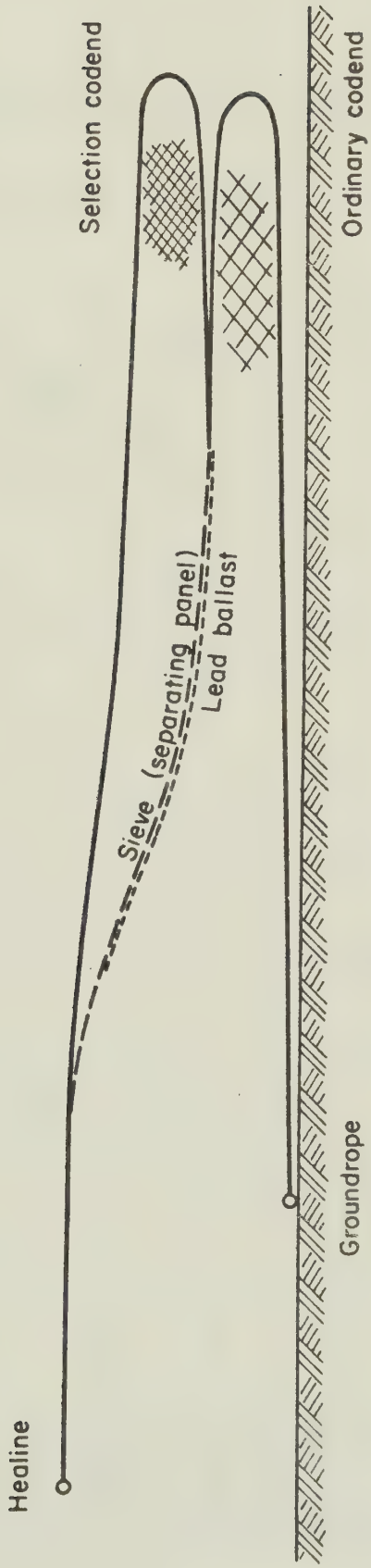

Fig. 1 Schematic longitudinal section of the selective shrimp trawl tested

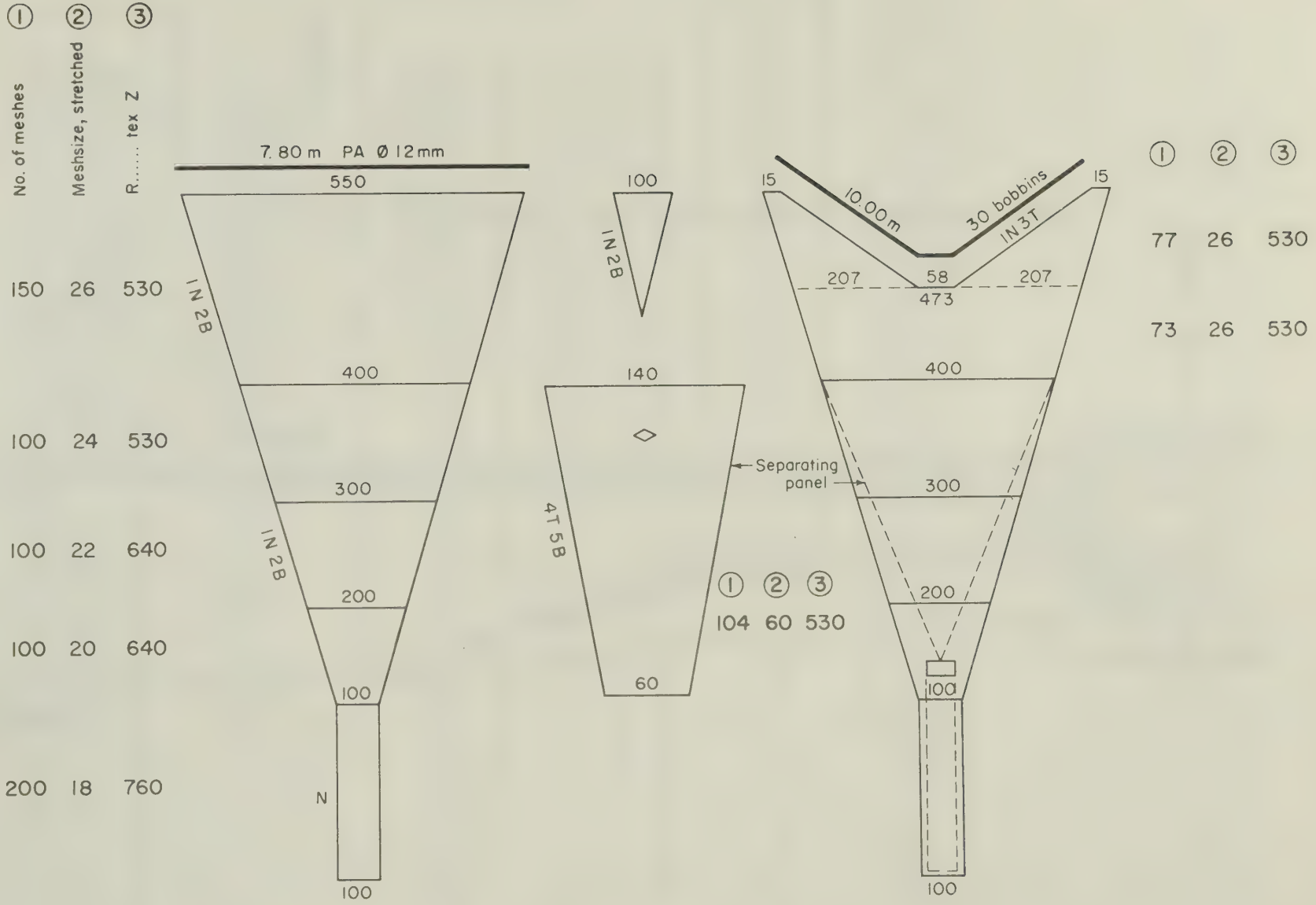

Fig. 2 Trial shrimp trawl with sieve (separating panel) for a beam of 8 m length

TABLE 1

Tow by tow selection of consumption shrimp

Wind force	Duration of tow (h)	Water depth (m)	Warp length (m)	Catch distribution percent	
				Ordinary (lower) codend	Selection (upper) codend
6	1	8	25	3	97
6	1	8	20	3	97
6	1	8	25	6	94
6	1	6	20	10	96
2	1	5	25	28	72
4	1	6	20	12	88
4	1	7	25	8	92
4	1	8	25	9	91
6	1	15	40	5	95
6	1	9	25	3	97
6	1	10	25	4	96
2	1	6	40	12	88
2	1	6	40	9	91
2	1	7	40	8	92
2	1	7	40	10	90
2	1	8	40	11	89
2	½	6	40	4	96
2	1	7	40	5	95
2	1	7	40	13	87
2	1	8	40	12	88
2	1	8	40	8	92

DEVISMES'S SELECTIVE TRAWL FOR BROWN SHRIMP (Crangon crangon)

by

J.C. Brabant

INTRODUCTION

This selective trawl is based on the different behaviour of shrimp and fish in the presence of an oblique netting panel within the trawl. The brown shrimp (Crangon crangon), disturbed by the groundrope, jump, pass through the separating netting panel and find themselves in the upper part of the trawl. Bottom fish have a tendency not to rise so much and to be guided by netting. They therefore pass underneath the separating panel and remain in the lower part of the trawl. In this way, the animals are separated in either of the two codends. The upper codend receives most of the shrimp; the lower codend, which could also be removed, most of the fish.

The description of this basic system has already been published in several articles. Mr. Devismes has recently made an interesting alteration to this trawl; this paper reports on sea trials with a trawl modified in this fashion and on observation of a model in the testing tank of Boulogne-sur-Mer.

DESCRIPTION

The selective trawl tested which was designed by Mr. Devismes (Fig. 1) is adequate for 80 hp vessels. It is made of nylon and has an 8.5 m headline and a 10.1 m groundrope. The upper panel is slightly wider than the lower panel. The front edge of the separating panel (meshsize 50 mm stretched) is fitted to the upper panel at the aft edge of the square. The side edges are taken in the side seams for a certain length and further aft sewn to the lower belly following a straight line of bars for a certain distance. Before meeting these seams diverge and lead directly to the rear end of the trawl. Through the passage formed, everything that has not passed the separating panel is guided into the lower codend.

The separating panel serves as a barrier for trash fish and debris but during towing it should not be lifted too much by the waterflow because this would interfere with the passage of shrimp.

The modification now introduced by Mr. Devismes is especially devised to prevent lifting of the separating panel which was previously attempted unsatisfactorily by attaching ballast.

The new system applies two additional small-meshed netting strips which are arranged vertically and in V-shape between separating panel and lower belly. The point of the V faces forward. The side edges of the netting strips are sewn to the separating panel and the lower belly respectively. This ensures that the middle of the separating panel is kept at a fixed distance from the lower belly which is equal to the width of the netting strips.

SEA TRIALS

The trials were carried out near the coast at a depth of 9 to 10 m in the region of Le Crotoy. To determine the efficiency of the separating panel, the trawl was fitted with small-meshed netting for both codends in order to retain the whole catch of fish and shrimp, so that the percentage of either in both codends could be recorded. Other trials, without the lower codend, proved that the yield was not impaired and that the operation did not seem to be handicapped by this experimental arrangement.

Flatfish found in the two codends were distributed as follows:

Upper codend Weight (kg)	Upper codend Percentage	Lower codend Weight (kg)	Lower codend Percentage
	DECEMBER 1970		
1.0	33	2.0	67
1.5	38	2.5	62
1.6	44	2.0	56
0.5	50	0.5	50
	APRIL 1971		
1.5	30	3.5	70
1.8	38	3.0	62
0.8	20	3.2	80
Average	36		64

Percentages of weight and specimens actually do not vary considerably if account is taken of the mortality of the younger specimens when comparing the catches in both codends.

The protection of immature flatfish does therefore not appear to be very good; furthermore, it has to be noted that all the soles caught were found in the upper codend.

Other fish, invertebrates

Sandeel is found in equal quantities of both codends. Callionymus, Liparis and Trigla are caught in the lower codend. Crabs are found mainly in the lower codend but pass also to the upper codend when they are numerous.

Jellyfish, found in April 1971, have only impaired the operation of the trawl during the first tow, when they were quite numerous.

OBSERVATIONS ON THE TRAWL MODEL

The model test in the tank has shown that the selective panel behaved correctly thanks to the alteration described. It would appear that the panel could be fitted more toward the front of the trawl. A method for the calculation of the size of the panel was devised to enable adaptation to various types of shrimp trawls. For this the differences in the shape of the mesh opening must be taken into account, i.e., 10 percent for the trawl itself and square for the separating panel. Coefficients have been calculated to convert the trawl size into the panel size.

CONCLUSIONS

If the above trials are compared to those carried out in 1964, the following can be noted:

(1) for flatfish, there is no improvement;

(2) for shrimp, loss decreased from 15 to 5.5 percent. It has thus become very low and is no longer an obstacle to the adoption of this selective system.

Unfortunately the protection of immature flatfish is not very satisfactory but it is not negligible and, taking into account the increased ease of shrimp sorting, this system merits to be adopted.

Unfortunately a third sea trip, foreseen for August 1971, did not materialize. According to Mr. Devismes there was then too much debris from the river which would have impaired the operation of the trawl with two small-meshed codends.

RESULTS

Shrimp

The shrimp yield (kg) was as follows:

Duration (min) of tow	Upper codend Weight (kg)	Upper codend Percentage	Lower codend Weight (kg)	Lower codend Percentage	Total catch (kg)
		DECEMBER 1970			
40	46	95.8	2.0	4.2	48.0
50	25	91.2	2.2	8.8	27.2
45	19	92.1	1.5	7.9	20.5
40	9	98.9	0.1	1.1	9.1
					104.8
		APRIL 1971			
73	7.8	72.0	3.0	28.0	10.8
60	9.1	94.0	0.5	6.0	9.6
65	12.0	95.2	0.6	4.8	12.6
					33.0

One particular tow showed a high percentage (28 percent) of shrimp in the lower codend. This abnormal occurrence is explained by the great abundance of small jellyfish which completely filled both codends. If this exceptional tow is omitted the average percentage of shrimp in the lower codend is about 5 percent. The selective system therefore makes it possible to retain about 95 percent of the shrimp and loss is very limited.

Flatfish

Only flatfish of commercial importance have been recorded and weighed, i.e., young soles (Solea vulgaris) and plaice (Pleuronectes platessa). Only a few sprats and turbots were taken. Of not marketable fish sandeel (Ammodytes lancelolatus), gurnard (Trigla sp.), dragenet (Callionymus sp.), Liparis sp., young lampreys (Lampetra fluviatilis) and gobies (Gobius minutus) were found.

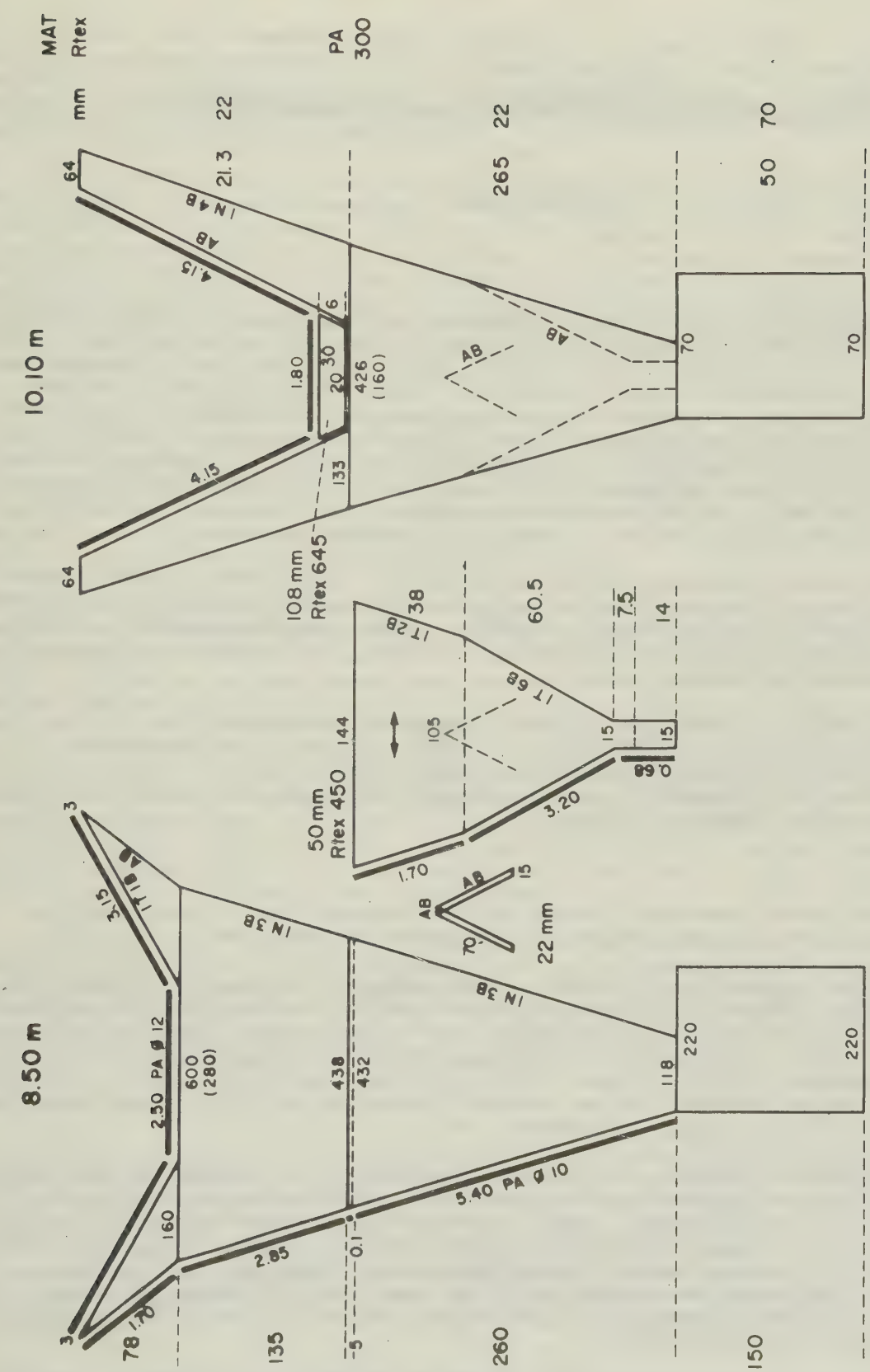

Fig. 1 Selective shrimp trawl for 80 hp (after Mr. Devismes)

A PROGRESS REPORT ON THE DEVELOPMENT OF A SELECTIVE SHRIMP TRAWL

by

Ian E. Ellis

INTRODUCTION

A major problem in the fishery for Pandalid shrimp in the northeastern Pacific Ocean is the incidental capture of organisms other than shrimp. Most, if not all of these organisms, must be removed from the catch before it can be sold. This is a laborious hand-sorting operation carried out on board the vessels. Hand-sorting occasionally continues 24 h per day and sometimes interferes with production because processing of one catch must be completed before another can be brought aboard. When the percentage of "trash" is too great, the entire catch is discarded. Fishermen avoid tows early in the morning, late in the evening, or in certain areas because of the high percentage of trash. The presence of fish and other organisms in the catch reduces the quality of the shrimp and causes the death of many fish including juveniles of commercially utilized species.

Publication of the results of early European selective shrimp trawl studies (Boddeke, 1965) stimulated interest in these trawls from the Conservation at the Engineering Programme of the National Marine Fisheries Service in Seattle. A study was begun in 1968 to develop an effective selective trawl for use in waters of the U.S.A. The attainment of this goal involved the following intermediate steps:

- identification of behaviour patterns of shrimp and associated fish;
- design, construction and evaluation of trawls which would take advantage of behavioural differences to selectively capture shrimp;
- demonstration of successful nets, procurement procedures, and rigging techniques to interested commercial fishermen.

BEHAVIOUR

In reviewing present knowledge of shrimp and fish behaviour several characteristics were found that had potential application to selective shrimp trawl design.

Scientist-diver observations of shrimp, including Pandalus platyceros, P. danae, and various Crangonids and Hippolytids indicated escape behaviour occurred only after physical contact and normally consisted of one horizontal jump for each contact, with vertical movement minimal or absent. Observations of P. jordani, the primary commercial species in our area, from the submarine PISCES, revealed similar behaviour (High et al., 1969). A diurnal cycle involving vertical movement had been observed (Schaefers and Johnson, 1957; Schaefers and Powell, 1958; Alverson et al., 1960; Pearcy, 1970).

Divers also reported flatfish were herded to the centre of an approaching otter trawl and remained as close to bottom as possible, most often passing under the footrope of a trawl as little as 15 cm off bottom. Round fish were similarly herded toward the centre of a trawl and tried to escape by lateral or upward movements. Usually the smaller, faster swimming pelagic fish, such as anchovy (Engraulidae), smelt (Osmeridae), and herring (Clupeidae) were "led" along the netting back in the trawl until stimulated to escape. Escape behaviour was nearly always rapid upward movement either in front of the headline or through the meshes of the trawl (Fig. 1).

Formal studies of shrimp behaviour with relation to fishing gear were begun in 1968. Small mesh pockets (meshsize 20 mm stretched) sewn on the outside of a shrimp trawl (mesh-size 50 mm stretched) revealed that most shrimp escaping from the net went through the sides

of the trawl. Some escapement occurred through the top panel, chiefly in the area just ahead of the codend where the net is restricted (High et al., 1969). Some shrimp dropped out through a large mesh belly panel in 1972 experiments (Fig. 2), but it was a small percentage of the catch. A sample of these shrimp from one catch showed them to be much smaller than those from the codend (Table 1).

Various interpretations have been made of observations of shrimp behaviour. Some evidence suggests that lateral "herding" of Pandalid shrimp, by dandylines or meshes large enough for the shrimp to escape, is minimal. When the back end of the trash chute (Fig. 3) of an experimental trawl was tied shut forming a collector bag, the presence of only a few shrimp at the conclusion of the tows indicated the incidence of shrimp being herded along the separator panel was low (Table 2). The alternate use of a tickler-chain for 22 tows preceding a vertical distribution sampler (VDS)[1/], produced evidence to suggest herding might be occurring. The tows with tickler-chain took nearly twice the weight of shrimp taken without the tickler-chain (Beardsley, 1973).

Although observation of shrimp behaviour suggests that the herding effect of a single strand of cable or chain would be minimal, a possible explanation exists. There are numerous flatfish on the shrimp grounds and they have often been observed responding to the stimulus of an approaching chain (Fig. 4). The result is that a band of moving flatfish, swimming close to bottom, occurs just ahead of the dandyline cable (sweepline) or tickler chain. One jump would often be sufficient for the shrimp to clear the cable or chain but several might be required to pass over a wide band of flatfish.

Some observations have been interpreted as demonstrating that shrimp rise up off bottom as the trawl approaches. During tests with the VDS a netting panel of 25 mm meshsize stretched was sometimes placed horizontally in front of the sampler at a point 91 cm off bottom. Shrimp catches were greater than average in the pockets just under this panel and smaller than average in the pocket above it. During alternate tows, when the horizontal panel was removed, the distribution was more uniform. Despite attempts to keep the VDS vertical and the horizontal panel perpendicular to it, the results would have been affected if the horizontal panel was slightly tipped to produce a shadow above and a concentrating effect below. When the VDS was towed with and without tickler-chain, most of the increased catch with tickler-chain occurred in the lower three bags (Beardsley, 1973). That these additional shrimp would have passed under the VDS without a tickler-chain seems most unlikely as the device was rigged to fish with the bottom of the frame in contact with the seabed and it is believed that it usually was within 7.5 cm of it.

Studies with the VDS revealed variations in shrimp distribution. The distribution varied with light level, near-bottom when bright and scattered from 0 to several metres off bottom when darker. Smaller shrimp generally stayed near bottom while larger shrimp dispersed more widely through the water column (Beardsley and High, 1970). Significant quantities of shrimp were sometimes found on bottom at night, generally when the preceding day was overcast or the water murky (Beardsley, 1973).

GEAR DEVELOPMENT

"Trouser trawls", with horizontal separator panels, employing the principles of Dutch sorting trawls (Boddeke, 1965), were tested but were not successful (High et al., 1969). One series of nine tows with a trawl of this type took an average of 44 percent of the shrimp and 51 percent of the fish in the upper codend. Another larger net took 63 percent of the shrimp and 74 percent of the fish in the upper codend in a series of four tows. Although shrimp did pass through the separator panels and the possibility of vertical movements existed, no matter how the panels were rigged there was always some obliquely oriented netting which would allow a shrimp to enter the upper codend without vertical movement.

1/ The shrimp vertical distribution sampler was designed to indicate the height of shrimp above the seabed by 30-cm (high) intervals. This device, resembling three ladders towed side by side in a vertical position, was towed from a trawler using otter boards and dandylines similar to those used with ordinary shrimp trawls

The first "winged shrimp trawls" (High et al., 1969) were constructed with an overhang. Later, tows with nets alternating with and without an overhang indicated little, if any, reduction in shrimp catch due to absence of the overhang. When the overhang was used, large numbers of smelt, one of the commercial fisherman's greatest problems, were caught. When the overhang was removed, the smelt catch was drastically reduced. In a selective trawl with an overhang, upward escape movements by smelt took them up through the separator panel into the shrimp bag.

Fishing trials aboard commercial vessels with these early nets produced mixed results. Catches contained very small percentages of trash; however, problems were encountered. The average size of shrimp captured by a winged selective shrimp trawl in one series of tows, was 20.3 mm carapace length and there were 34.7 shrimp/kg. Samples of shrimp taken by three standard semi-balloon trawls in the same area at the same time were larger, averaging 20.6 mm long, but lighter, averaging 36.2 shrimp/kg. Although these differences do not appear to be statistically significant, similar observations have been made enough times to indicate a trend. The quality of shrimp caught in the wing trawl was excellent but the catch rate was only 55 percent of that by the semi-balloon trawls (Table 3). The net required extreme weighting to fish near bottom, apparently due to the hydrodynamic lift produced by the separator panel which was tilted by the overhang (High et al., 1969).

Later designs were built with equal length headline, footrope and midlines on the separator panels. One of these, the "707" trawl was essentially two wing trawls, one atop the other. This net had a trash chute opening down in the lower half and one opening up in the upper half. It was complete with upper and lower codends. The catch rate in test tows with this net was low, probably due to high drag reducing the opening of the trawl (Beardsley and High, 1970).

Another net, built at about the same time (mid-1969) was the "57-ft (17.1-m) semi-ballon trawl", modified for separating fish from shrimp (drawing in Beardsley and High, 1970). It had a separating panel of 50 mm meshsize stretched, 120 meshes high and a midline equal in length and parallel to headline and footrope. With a measured vertical height of 2.44 m, there was a catenary or sag of about 60 cm in the separator panel. The net was used for commercial fishing during the last six weeks of the 1969 season by the vessel CORSAIR, producing more shrimp than most of the vessels in the area with one less man in the crew (Beardsley and High, 1970).

This success created great interest in the gear. Several seminars for commercial fishermen were held during 1970 at which net construction and operation were discussed and several commercial nets were modified into selective trawls. Designs for two more models of selective trawls (a 53-ft (15.9-m) net and an 80-ft (24-m) net) were made available to commercial net makers for construction of new nets. Ten or more selective trawls were completed including at least five modified 57-ft (17.1-m) semi-ballon trawls and at least five other nets. Several of these nets worked very well in the commercial fishery during 1970 and 1971 but none were used during 1972 (Jurkovich and Robinson, personal communications).

The disappearance of this gear from the fishery was due to several factors. Some of the nets were incorrectly made, did not work and were discarded. One net was distorted by hitting a snag and the owner did not know how to fix it. Another was very successful[1/] but the owner thought it too big. He tried to modify it, distorted it so it would not fish and could not rectify his mistake. Several nets belong to fishermen who have gone, at least temporarily, into other fisheries. Some of the nets have been worn out.

1/ Fished from the 110 hp vessel SHADOW DO in competition with much longer and more powerful vessels; the net was the second best producer for a period of several weeks in 1970

Discussions with fishermen in July 1971 revealed several pertinent facts. Selective shrimp trawls used by commercial fishermen caught a much lower percentage of fish but the shrimp catch was lower than that of a standard trawl. They still retained enough fish that some hand sorting was usually necessary. Although the rate of catch of smelt was much lower than by standard nets, they were sometimes caught in large numbers. It was nearly impossible to obtain a dependable selective trawl from commercial net makers and too few of the fishermen know enough about net building to make one or correctly repair it when badly damaged (Jurkovich, personal communication).

The understanding of the effects of selective trawls increased during research cruises in 1972. An experimental trawl and a standard trawl were towed simultaneously, side by side, which permitted rapid accurate assessments of the effect of differences between nets (Fig. 5). Divers observed that water pressure held flatfish against the separator panel near the bosom of the net (Fig. 6). This effect occurred over a large part of the centre of the net which was nearly perpendicular to the direction of tow (Fig. 3). There appeared to be virtually no leading of fish toward the middle except near the wingtips and immediately adjacent to the trash chute. The 1972 selective trawl (Fig. 7) took about half of the volume of shrimp taken by a standard net fished simultaneously in 10 and 15 min tows. The ratio changed in longer tows of 1-4 h duration, the selective trawl catches averaging about 75 percent of the standard trawl catches.

It was deducted from this evidence that flatfish held on the separator panel block the passage of shrimp through the panel. During short tows, many shrimp apparently do not find a way through the panel before towing ceases. During retrieval, due to the inadequate auxiliary power of the vessel, the net velocity reduced by about half, which could have allowed shrimp and fish to drop off the separator panel and escape. Although the results are better with longer tows, there still must be some incidence of loss of shrimp under the footrope or over the headline.

The shape of the separator panel of the net tested in 1972 was different from those of earlier nets, since the separator panel was more nearly flat in cross section, due to three horizontal midlines dividing it into four equal strips. This reduced the maximum sag from 60 cm or more with one midline, to about 38 cm. The primary objective of this flattening was to reduce the catch of smelt and it seemed to be successful. During a series of eight short tows, the standard net took 608 kg of shrimp and 61 kg of smelt while the selective trawl took 284 kg of shrimp (46.7 percent as many) and 1.2 kg of smelt (1.9 percent as many).

The programme for 1973 includes testing of the next generation net (Fig. 8). This net, like the 1972 model, has 22-m long separator panel and midlines. A 57-ft (17.1-m) semi-ballon trawl is used as the standard in dual net test tows as it also has a 22-m footrope and roughly the same horizontal opening. The net has a 61-cm wide, full-height opening in the centre of the separator panel, which is connected by an intermediate tunnel to a "trash codend". This experimental feature was substituted for the trash chute(s) to allow for anticipated great increases in quantity of material captured and allow accurate assessment of leading. The most important change is the addition of top and bottom panels of 280 mm meshsize stretched nylon netting in front of the separator panel. These panels will serve to support the separator panel in a V-shape (plan view), with about a 90° angle between halves, each half at an angle of 45° to the direction of tow. This configuration should provide a much greater leading stimulus for fish to the centre than was obtained with the semi-circular configuration of the unsupported separator panels of earlier nets. A greater catch of shrimp in the "trash codend" is anticipated than was obtained in a closed trash chute, but some compensation is expected, due to a reduction in loss around the headline and footropes. The addition of a top panel could be expected to produce increased smelt catches but by using very large mesh it is hoped to reduce this effect.

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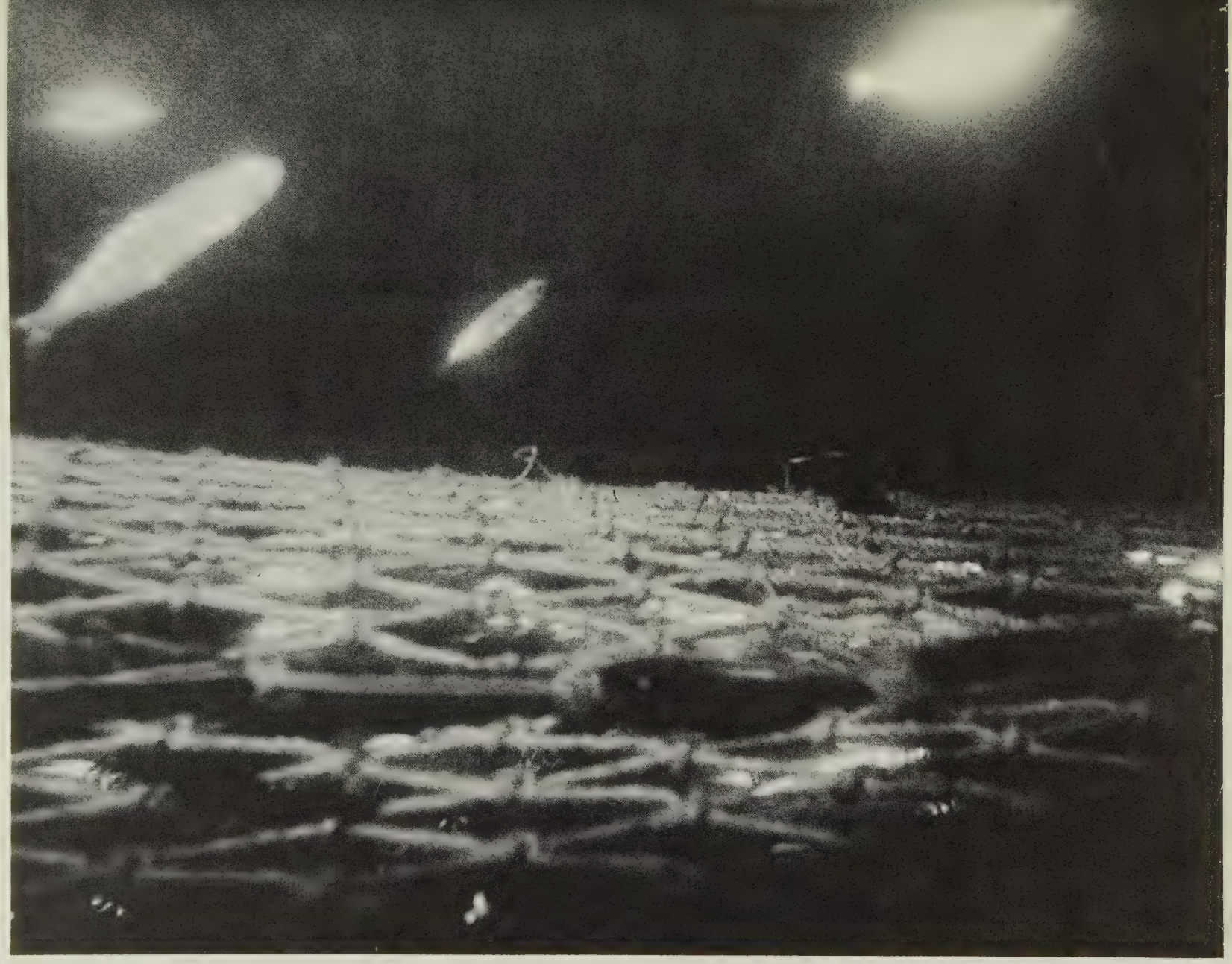


Fig. 1 - Smelt and herring escaping from the codend of a trawl

Fig. 2 - Front view of a selective shrimp trawl showing patch-bags on the large mesh

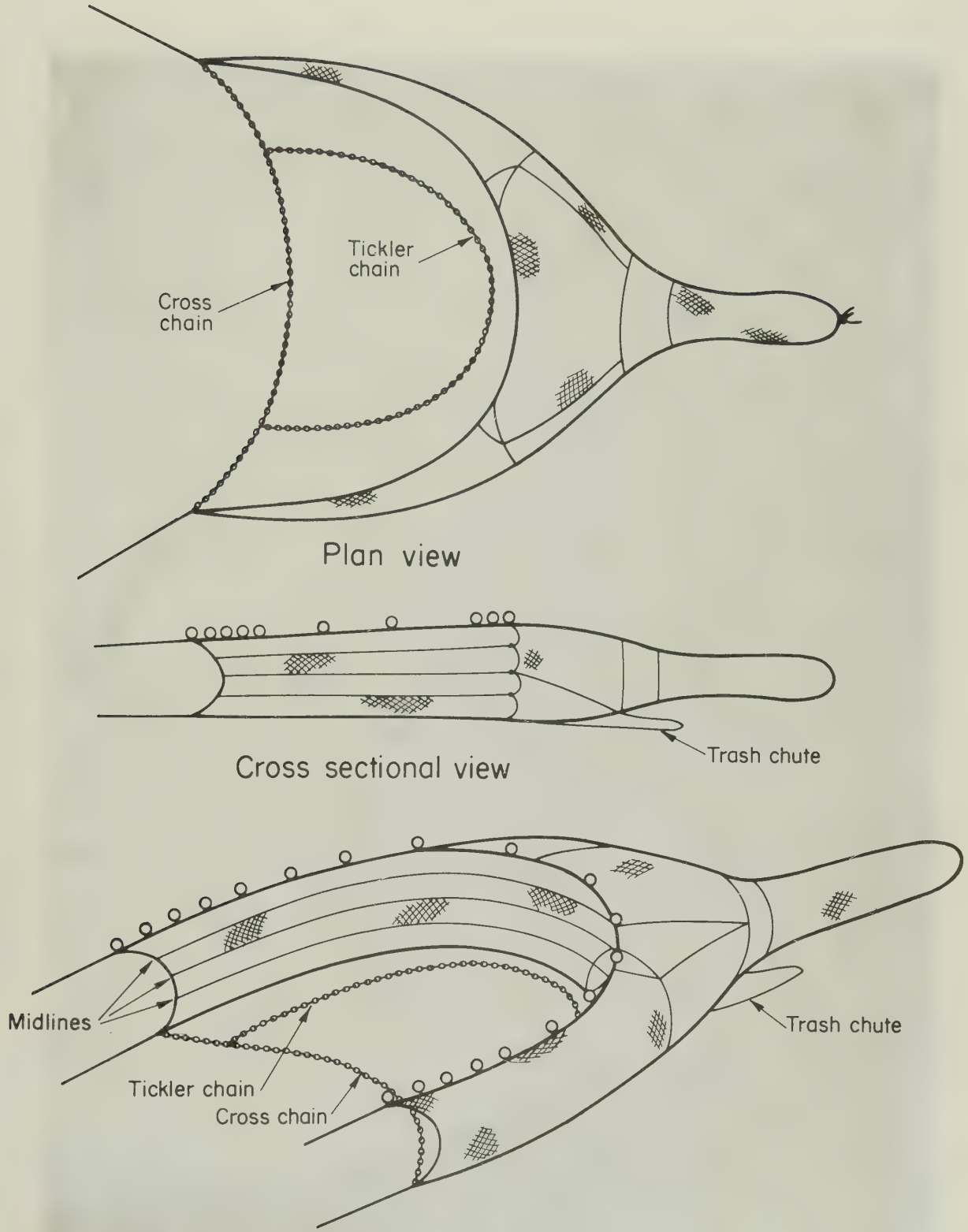


Fig. 3 - Fishing configuration of a selective shrimp trawl. The 1972 model is shown; however, the semi-circular configuration shown in the plan view is typical of most NMFS selective shrimp trawls

Fig. 4 - Flatfish responding to an approaching tickler chain

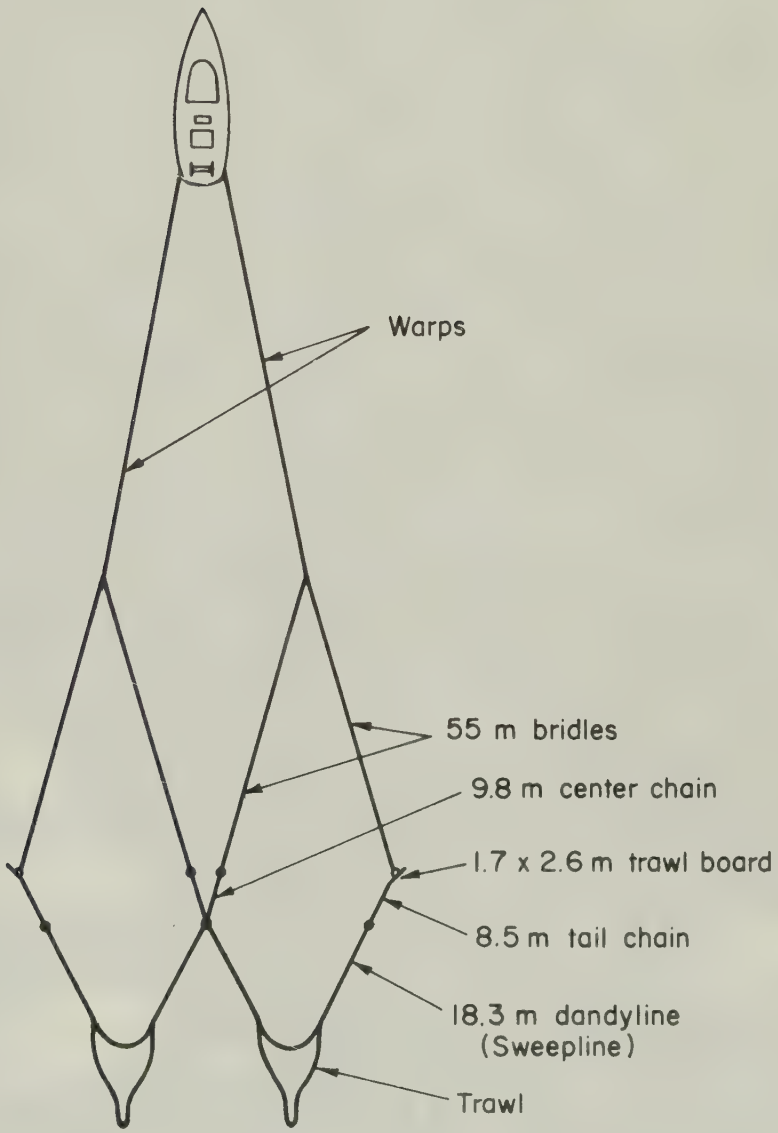


Fig. 5 - Method of towing two different nets simultaneously from a single rigged stern trawl vessel

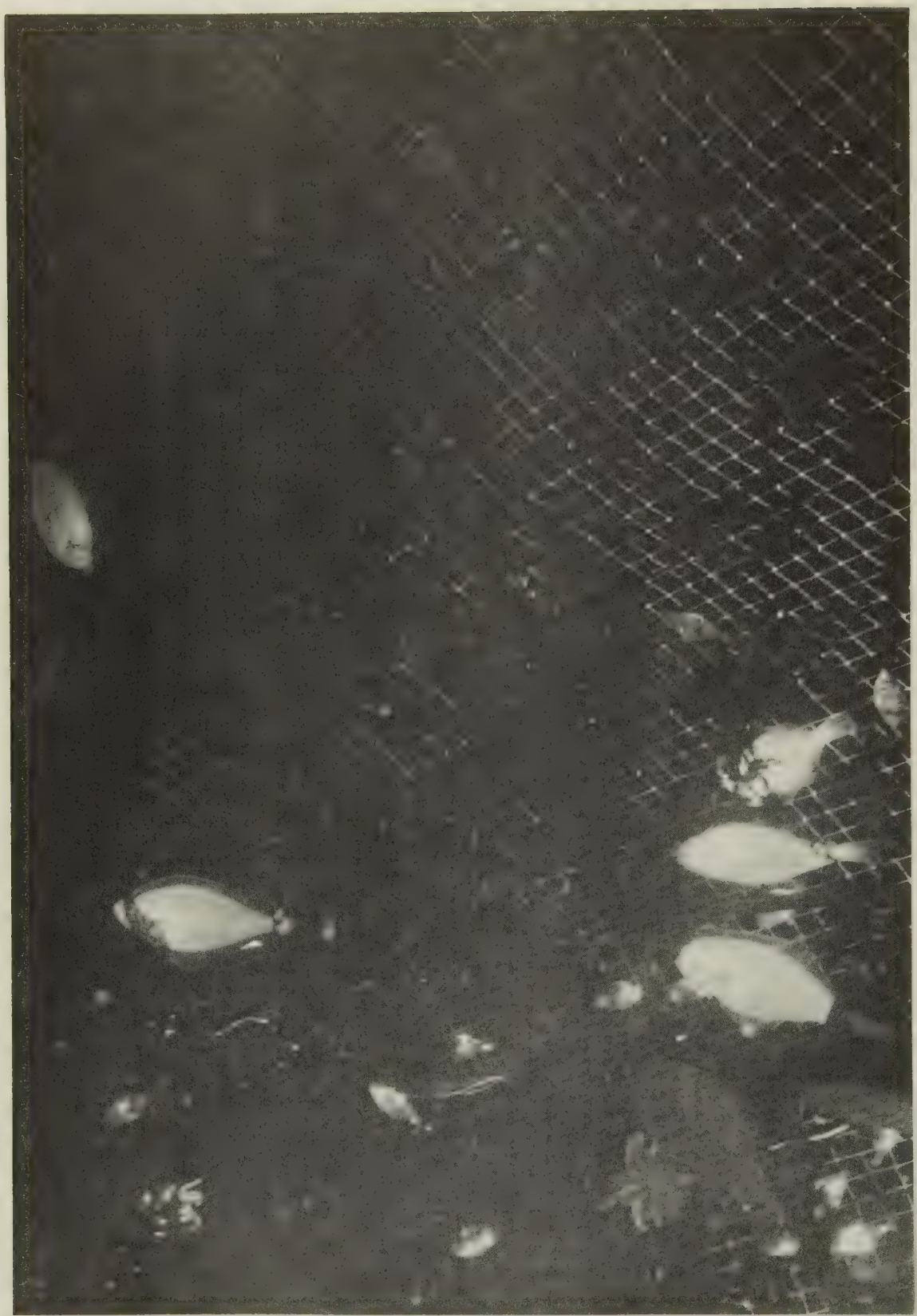
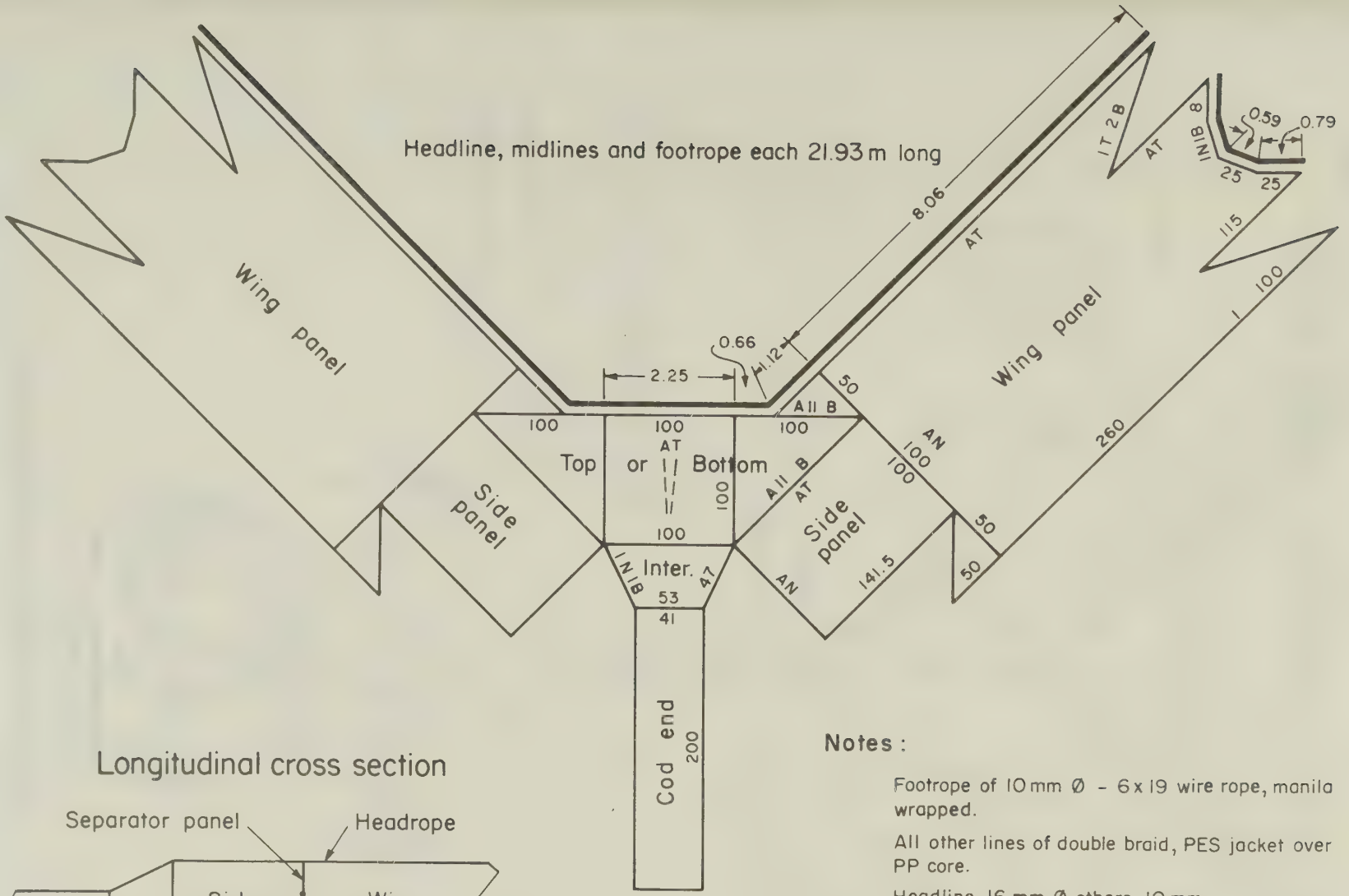
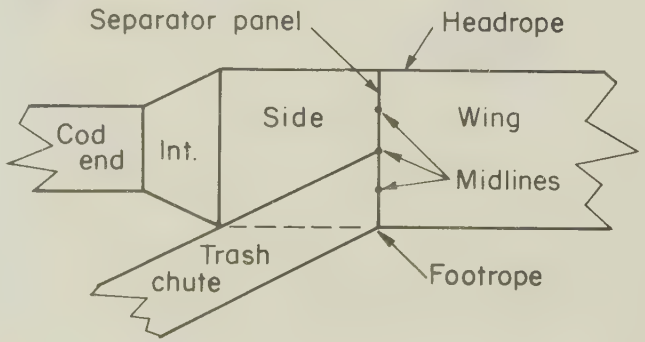


Fig. 6 - Separator panel of a selective shrimp trawl showing flatfish impinged on the panel by the towing pressure.



Longitudinal cross section



Notes :

Footrope of 10 mm Ø - 6 x 19 wire rope, manila wrapped.

All other lines of double braid, PES jacket over PP core.

Headline 16 mm Ø others 10 mm.

Separator panel 50 mm meshsize stretched PA, R 1600 tex.

Codend 40 mm meshsize stretched PA, R 4000 tex.

All other netting 32 mm meshsize stretched PA, R 990 tex.

Intermediate of 4 identical panels (1 shown)

Fig. 7 - The 1972 selective shrimp trawl

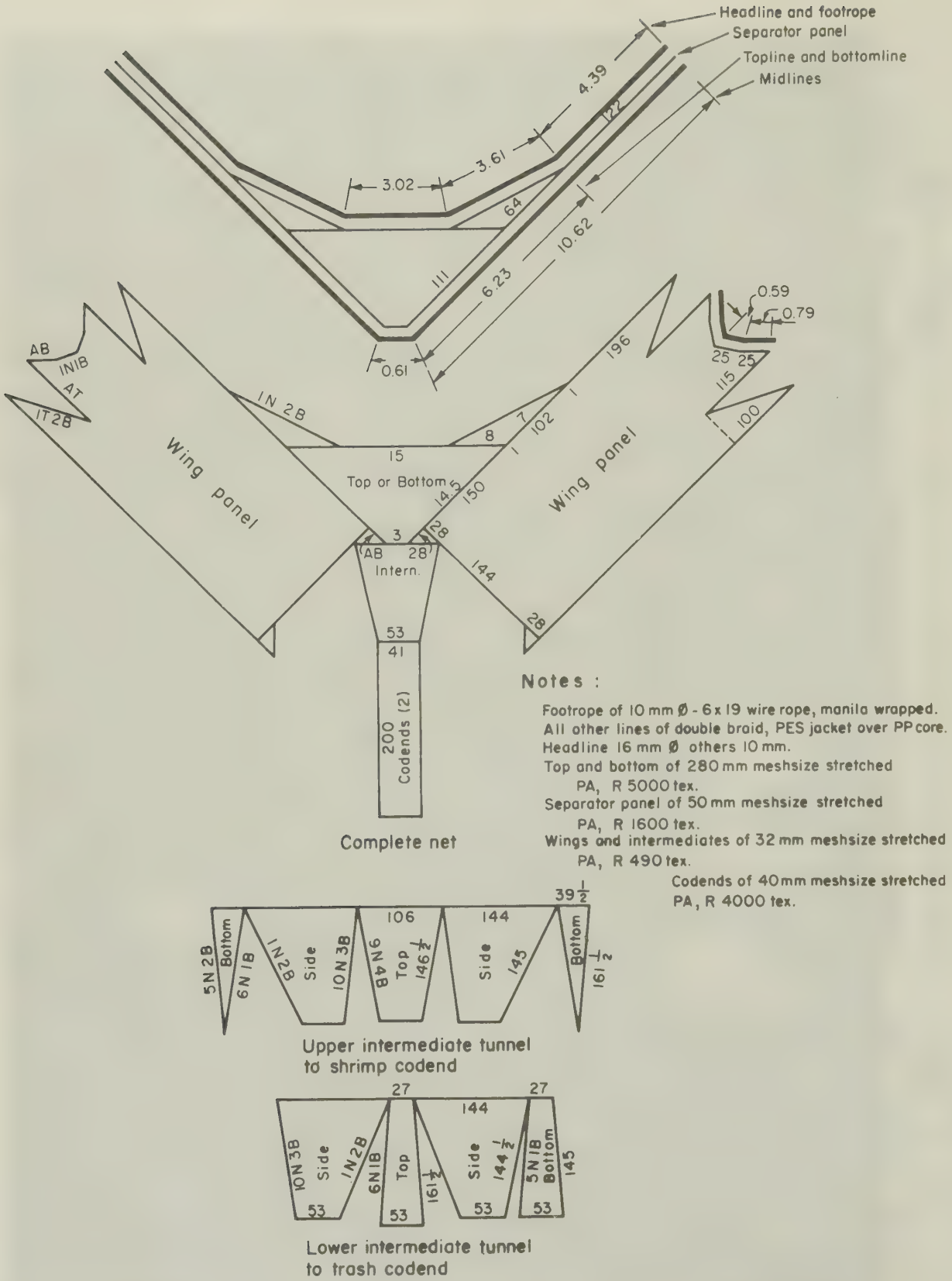


Fig. 8 - 1973 NMFS selective shrimp trawl

TABLE 1

Mean lengths and weights of shrimp taken by a standard net and a selective shrimp trawl fished simultaneously, side by side

Tow number	17.1-m semi-balloon trawl		Shrimp separator trawl	
	Mean carapace length (mm)	No. of shrimp/kg	Mean carapace length (mm)	No. of shrimp/kg
61	17.9	51.5	18.5	51.5
63	17.7	53.3	17.9	55.5
65	17.5	56.6	17.4	56.6
67	17.6	59.5	18.3	57.5
69	17.2	64.5	17.3	56.8
71	18.2	59.0	17.3	57.3
74	17.6	57.6	18.4	53.4
76	18.2	59.1	18.7	49.7
Mean for above tows	17.7	57.6	18.0	54.7
Sample of shrimp taken from patch bags under belly panel - tow number lost			15.9	86.5

TABLE 2

Composition of catches taken by a control net (17.1-m semi-balloon trawl) and a selective shrimp trawl fished simultaneously during cruise 72-7 of RV JOHN N. COBB

Tow No.	Duration (min)	Control net				1972 selective shrimp trawl					
		Shrimp		Fish		Codend				Trash chute		Belly	
						Shrimp		Fish					
		(kg)	% of total	(kg)	% of total	(kg)	%	(kg)	%	Shrimp (kg)	Fish (kg)	Shrimp (kg)	Fish (kg)
66	10	33	61	21	39	27	95	1.5	5	1.3	1	2.2	0.2
67	10	110	79	30	21	35	93	2.5	7	-	-	1.3	0.5
68	10	64	71	25.5	29	41	98	0.8	2	3.4	2.7	2.2	0.2
69	10	59	68	28	32	35	94	2.3	6	-	-	0.4	0.2
70	10	56	83	12	17	27	95	1.5	5	1.3	12	1.3	0.4
71	10	58	84	11	16	34	96	1.2	4	1.3	9	1.8	0.6
72	10	113	76	35	24	67	94	4.5	6	1.3	16	2.7	0.9
74	10	92	85	16.5	15	45	92	4	8	2.2	21	1.3	0.6
75	10	108	78	31	22	40	95	2.2	5	1.3	8	3	0.6
76	10	73	62	45	38	63	91	6	9	1.8	23	1.8	0.6
77	10	93	59	65	41	39	95	2	5	-	-	-	-
82	10	47	9	47	91	23	90	2.5	10	-	-	-	-
83	10	99	45	121	55	51	94	3	6	3	25	7	1.3
84	10	159	68	74	32	79	98	1	2	3.5	32	0.2	0.2
86	10	87	50	86	50	42	94	2.7	6	1.3	32.7	0.7	0.6
87	10	115	49	121	51	54	96	2	4	1.3	22	2.7	0.9
Total		1 366		1 190		703		51		24	204	30	8.5
Mean		85	53	74	47	44	93	3	7	2	17	2	0.5
73	60	387	87	56	13	215	95	11	5	-	-	-	-
78	60	199	80	50	20	170	94	11	6	-	-	-	-
79	120	523	41	750	59	355	97	9	3	-	-	-	-
80	240	909	49	962	51	977	98	23	2	-	-	-	-
81	60	489	57	375	43	330	97	11	3	-	-	-	-
Total		2 507		2 194		2 046		66					
Mean		501	53	439	47	409	97	13	3				

TABLE 3

Comparison of shrimp catches by a selective "winged shrimp trawl" and three standard semi-balloon trawls fished in the same area during the same time period

Vessel	Gear	Date	h fished	Catch of shrimp		Size of shrimp	
				Total (kg)	kg/h	Mean carapace length (mm)	Number/kg
WASHINGTON	winged shrimp trawl	10 August 1968	1.3	864[a]	665		
(300 hp)	trawl	10 September 1968	3.6	1 318[b]	366		
(300 hp)	trawl	combined	4.9	2 181	445	20.3	35
WASHINGTON	semi-balloon trawl	10 September 1968	2.3	1 818[c]	790	20.5	36
WESTERN MAID	semi-balloon trawl	10 August 1968	3.5	2 045	585		
WESTERN MAID	semi-balloon trawl	10 September 1968	5.0	4 773	955		
WESTERN MAID	semi-balloon trawl	combined	8.5	6 818	802	20.6	39
TRASK	semi-balloon trawl	10 August 1968	5.8	3 636	627		
(220 hp)	semi-balloon trawl	10 September 1968	4.2	4 550	1 082		
(220 hp)	semi-balloon trawl	combined	10.0	8 571	818	20.7	35
COMBINED	semi-balloon trawl	combined	20.8	16 818	809	20.6	36

a/ The incidental catch of fish during this tow was estimated at 2.2 kg

b/ The incidental catch of fish during this tow was estimated at

c/ The incidental catch of fish during this tow was estimated at

FISHING EXPERIMENTS WITH SELECTIVE SHRIMP TRAWL IN NORWAY 1970 to 1973

by

B. Rasmussen

BACKGROUND

For a number of years fishery surveys have been carried out in the Barents Sea to chart new fishing grounds for deep-sea shrimp (Pandalus borealis). During this survey work, it appeared that the trawl, besides shrimp, also caught great numbers of undersized and juvenile fish, particularly haddock, redfish (Sebastes) and cod. This was also the case in the inshore fishery for Pandalus in some of the fjords in northern Norway. It is a well known fact that stocks of cod and haddock in the Barents Sea, for instance, are already subject to a hard taxation by an international fishing fleet. The expanding fishery for deep-sea shrimp in this area had to be considered as an additional danger to these fish stocks. The shrimp trawls caught large numbers of small juvenile fish, which were not taken in the ordinary fish trawls.

At the Institute of Marine Research in Bergen, Norway, it was considered of great importance to construct and introduce a shrimp trawl able to sort out the small fish so that they could survive and grow up, while at the same time ensuring satisfactory catches of shrimp.

In the fishery for shrimp (Pandalus jordani) on the west coast of the U.S.A., problems are similar, with large catches of small fish while trawling for shrimp. The problem was taken up by the Exploratory Fishing and Gear Research Base of the U.S. Department of Commerce in Seattle, Washington, U.S.A. By studying the behaviour of the shrimp and the fish in front of the trawl, certain principles for the construction of a selective shrimp trawl were determined. A sketch showing the construction principles for the "sorting trawl" arrived at is shown in Fig. 1. In this design, the "overhang" found in ordinary trawls has been discarded so that the headline and footrope are of equal length. Observations by underwater divers had shown that fish like redfish, cod and herring had a tendency to ascend toward the ceiling when scared by the footrope, while the shrimp lifted only 30 to 60 cm from the bottom before entering the trawl. The removal of the overhang should thus not influence the catch of shrimp. It was discovered later, however, that this does not hold true under all conditions, e.g., in cloudy weather.

The most important feature of the new trawl construction is the inset of a separator net in the trawl mouth. This separator net stretches from footrope to headline and is strengthened by a midline. The separator net has a meshsize (stretched) of 50 to 60 mm, which allows the shrimp to pass through, while the fish is guided toward two fish chutes, one in the lower part, and one in the upper part of the separator net. The fish will escape through these chutes. This "sorting trawl" was tried commercially on the American west coast in the spring of 1970 with encouraging results. However, later on, certain modifications have been made in the original trawl design to suit local conditions.

In Norway, some preliminary experiments were carried out in 1970 and 1971 with a small ordinary wing trawl of Norwegian design. In 1972 and 1973, the experiments were extended to include larger shrimp trawls used in oceanic fishery, such as the "Sputnik Trawl" and the "Kodiak Trawl". The field work has been carried out by Captain A. Strøm and Mr. P. Øynes on the research staff of the Institute of Marine Research.

TRAWL TYPES TESTED

The different shrimp trawls used in the fishing experiments may briefly be described as follows:

Wing trawl This trawl is partly used by smaller shrimp boats fishing in the fjords in northern Norway. The wing trawl used in our experiments had a 38 m footrope, with long wings, a relatively short overhang and a low opening in the mouth. It measured 1 050 meshes or 42 m in circumference at the mid-point of the footrope. One of the trawls was equipped with a vertical separator net with a meshsize of 60 mm stretched. Likewise, a midline and 2 fish chutes were installed as in the American design. In another wing trawl, the overhang was removed so that footrope and headline were of equal size, while the separator net was mounted as in the American trawl.

Sputnik trawl This trawl is widely used in Norway in the shrimp fishery in the Barents Sea and in the offshore fishery in southern Norway. It has been found efficient in catching shrimp in deep water (200–600 m), but at the same time it can take large catches of fish. The Sputnik shrimp trawl is constructed largely along the same principles as the trawls used for herring and industrial fish in the North Sea.

The Sputnik trawl used in our experiments was 58 m along the footrope, and 46 m along the headline. It measured 1 300 meshes in circumference at the mid-point of the footrope, has a 3 to 4 m overhang, and a very high mouth. In one of the experimental trawls a vertical separator net was mounted from the mid-point of the footrope to the ceiling, with a midline and 2 chutes. In another experimental Sputnik trawl a separator net was mounted stretching obliquely from the footrope backward toward the ceiling, with a fish chute at the top part.

Kodiak trawl The ordinary Kodiak trawl used in the deep-sea shrimp fishery is a balloon trawl made of heavy twine. It must be characterized as a heavy trawl built for larger vessels fishing in the Barents Sea, off Spitsbergen and in Greenland waters. This trawl is ordinarily used with rubber rollers or bobbins along the footrope. It has short wings, short overhang and a comparatively low mouth opening.

The experimental trawl was 22 m along the headline, 27 m along the footrope and measured 1 300 meshes in circumference at the mid-point of the footrope. A separator net was mounted from the footrope vertically to the ceiling over a midline. Instead of fish chutes, the overhang in front of the separator net was made of large mesh netting of 130 mm meshsize stretched through which fish which were stopped by the separator net should escape. This would eventually make the construction of a selective shrimp trawl much easier.

FISHING EXPERIMENTS

All the experiments carried out in the different areas over a number of years with the various trawl types cannot be described in detail; they will therefore be summarized.

Results of fishing experiments in various areas with the Sputnik trawl are given in Table 1.

On the North Cape and in Porsanger Fjord in northern Norway the mean catch of young fish in the ordinary Sputnik trawl was 381 and 1 028 specimens respectively, mostly cod, haddock and redfish. By using the vertical separator net, the number of fish was reduced by 71 and 64 percent respectively.

In southern Norway, the fish catch mostly consists of industrial species as Norway pout, blue whiting and silver smelt. In the three fishing grounds tested the number of fish for the ordinary Sputnik trawl was on an average between 318 and 1 357 specimens for a 2-h tow. When using the vertical separator net, the fish catch was reduced by more than 90 percent on two grounds, while in another, there was an increase in the fish catch

of 66 percent. It was not only the fish catch, however, which was reduced by the vertical separator net, but also the shrimp catch became smaller by 50 to 75 percent on the various shrimping grounds.

The experiments with an oblique separator net in the Sputnik trawl showed similar results. The fish catch was reduced by 55 to 83 percent on the various grounds, and at the same time the shrimp catch was reduced by 33 to 40 percent in northern Norway and up to 91 percent in southern Norway.

The results of the experiments with the ordinary wing trawl and the heavy Kodiak trawl are given in Table 2. In northern Norway (Porsanger Fjord) the shrimp catches were generally small with the wing trawl, the mean catch being 8 kg of shrimp and 485 specimens of fish/2-h haul. The same trawl, with separator net, gave about the same shrimp catch, while the number of fish was reduced by 94 percent. In southern Norway (Al Fjord) the ordinary wing trawl also gave small shrimp catches (8 kg) while the average fish catch was 740 specimens/ 2-h haul. The wing trawl with separator net gave about the same small shrimp catch while the number of fish caught was reduced by 89 percent.

The large and heavy Kodiak trawl has been less experimented with, as compared to the Sputnik and wing trawls. One tow with the Kodiak trawl on the North Cape Bank gave a catch of 125 kg of shrimp and 550 specimens of fish. The same trawl, with separator net, gave an increase in the shrimp catch of 54 percent while the fish catch was reduced by 75 percent. In this experiment, the vertical separator net had no fish chute, but the overhang above and in front was made of large meshes.

DISCUSSION OF THE RESULTS 1970 TO 1972

It appears that the Sputnik trawl with separator net gave satisfactory results as regards the escape of fish. At the same time, however, the shrimp catch is similarly reduced which, from a fisherman's viewpoint, can hardly be accepted. The experiments with the oblique separating net gave hardly better results. One problem not shown in the tables is recurring mud hauls and torn nets. In the trawl with oblique separating net, tearing of the trawl net occurred mostly in the ceiling in front of the fish chute. These accidents necessitated steady repairs and loss of effective fishing time. All the mud hauls with the Sputnik trawls have been omitted from the tables.

Past experience with the Sputnik trawl shows that it is very difficult to convert this gear into a good selective shrimp trawl with satisfactory sorting ability, due to its special construction with great width and height in the trawl opening. The vertical separator net in the Sputnik trawl must have a large area, which is subject to great water pressure during towing and the trawl is probably being deformed and compressed. Further experiments with this trawl will therefore be discontinued for the time being.

As regards the wing trawl experiments have generally given small shrimp catches as compared with thosetaken with other trawl types, despite the size of the wing trawl, which should warrant better results. During the experiments only light trawl boards (70 to 100 kg) were available for the wing trawl, and it is possible that the trawl did not achieve its full spread with these boards. The wing trawl with separator net shows,on the other hand a satisfactory ability to sort out the fish while the shrimp catch remains the same.

The heavy Kodiak trawl shows the best ability to catch shrimp. With separator net, as was the case for 5 hauls, the trawl also shows a great ability to sort out the fish while maintaining or even improving the shrimp catch.

The results of trawling experiments to the end of 1972 were thus discouraging for the trawl mostly used in Norway, i.e., the Sputnik trawl, while the more "oldfashioned" wing trawl and the newly introduced Kodiak trawl showed more encouraging results.

TRAWLING EXPERIMENTS IN THE SPRING OF 1973

Based on the experience gained through the earlier trawling experiments, it was decided to discontinue the trials with the Sputnik trawl. Some more experiments with the wing trawl were desirable, this time with larger trawl boards. Likewise, it was decided to experiment further with a Kodiak trawl, but this time the trawl was made of very light twine so that it could be used by smaller vessels. The new light Kodiak trawl, as well as the wing trawl, had a separator net, a supporting midline and two fish chutes as in the American original type. One light Kodiak trawl without separator net was used as a control.

The fishing experiments took place in May 1973 off the coast of northern Norway. Weather conditions were very variable with sudden gales; at times a heavy growth of green algae in the sea clogged the meshes of the separator net and of the trawl. This limited the number of tows which could be made. Preliminary results of the May 1973 experiments are given in Table 3, which contains only the trawl tows taken as far as possible under similar conditions. During the experimental fishery other vessels were fishing with Sputnik trawls on the same ground. It appeared that the shrimp catches taken by the experimental trawls were on the same level as those taken by the commercial vessels.

It will appear from Table 3 that the average catch of shrimp in the ordinary light Kodiak trawl was 28 kg and the fish catch 817 specimens/2-h tow. The Kodiak trawl with separator net (meshsize 60 mm stretched) had 18 percent less shrimp, while the fish catch was reduced by 98 percent.

The use of larger trawl boards (500 kg) with the wing trawl with separator net (mesh-size 60 mm stretched) resulted in shrimp catches which were fully comparable with those taken by Sputnik and Kodiak trawls. The wing trawl caught 33 percent more shrimp than the ordinary Kodiak trawl without separator net, while the fish catch was reduced by 96 percent.

The experiments carried out in May 1973 seem to indicate that the future solution to the problem of saving small fish while maintaining a satisfactory shrimp catch lies in the further experimentation with the Kodiak and wing trawl with separator net and in the tentative introduction of such selective trawls in the commercial fishery. It is hoped that experiments can be continued in the summer of 1973, in combination with the charting of new shrimp grounds in the Barents Sea.

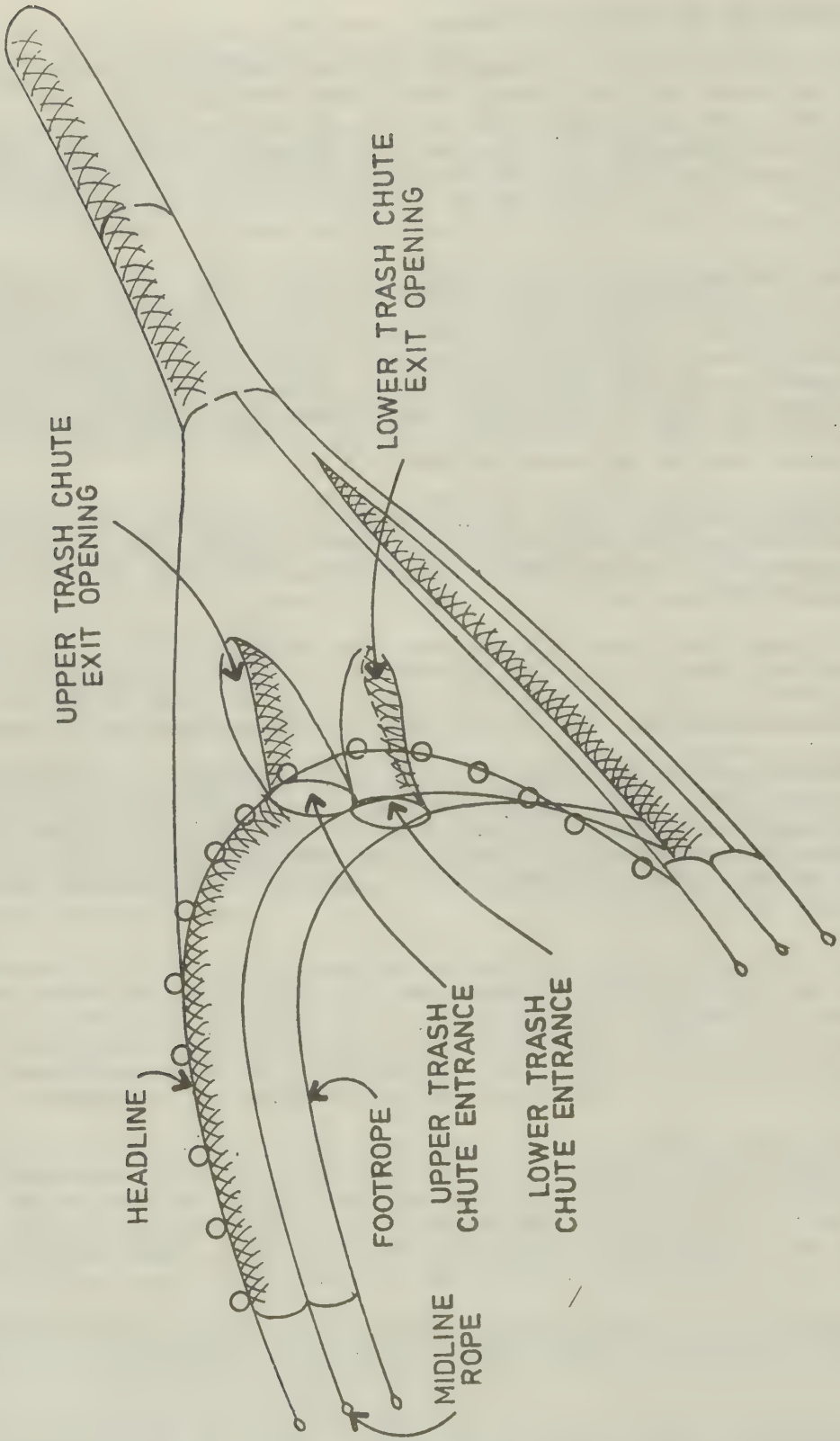


Fig. 1 Schematic view of the U.S. selective shrimp trawl

TABLE 1

Comparative fishing experiments with separator net in a Sputnik trawl 1970 to 1972

Fishing gear	Fishing grounds	No. of tows	Catch/2 h		Difference, percent	
			shrimp (kg)	No. of fish	shrimp (kg)	No. of fish
without separator	North Cape Bank	17	91	381	-	-
with vertical separator		13	46	109	-50	-71
with oblique separator		21	55	81	-40	-79
without separator	Porsanger Fjord	18	45	1 028		
with vertical separator		4	16	373	-67	-64
with oblique separator		9	30	463	-33	-55
without separator	Utsira Ground 1971-72	5	4	687		
with vertical separator		2	1	40	-75	-94
with oblique separator		3	1	114	-75	-83
without separator	Karmøy Sound 1972	10	22	1 357		
with vertical separator		8	6	100	-73	-92
with oblique separator		3	2	360	-91	-73
without separator	Al Fjord 1971	8	18	318		
with vertical separator		2	7	530	-61	+66
with oblique separator		3	15	52	-17	-83

TABLE 2

Comparative fishing experiments with separator nets in a wing trawl and a Kodiak trawl 1970 to 1972

Fishing gear	Fishing grounds	No. of tows	Catch/2 h		Difference, percent	
			shrimp (kg)	No. of fish	shrimp (kg)	No. of fish
Wing trawl:						
without separator	Porsanger Fjord	12	8	485		
with vertical separator		16	7	31	-9	-94
without separator	Al Fjord	2	8	740		
with vertical separator		4	9	84	+12	-89
Kodiak trawl:						
without separator	North Cape Bank	1	125	550		
with vertical separator		5	192	136	+54	-75

TABLE 3

Comparative fishing experiments with separator nets in a wing trawl and a Kodiak trawl 1973

Fishing gear	Fishing grounds	No. of tows	Catch/2 h		Difference, percent	
			shrimp (kg)	No. of fish	shrimp (kg)	No. of fish
Light Kodiak trawl without separator	North Cape Bank	12	27.7	816.5		
Kodiak trawl with vertical separator		8	22.6	17.1	-18.4	-97.9
Wing trawl with vertical separator		3	36.7	32.0	+32.5	-96.1

SELECTIVE SHRIMP TRAWL EXPERIMENTS IN ICELANDIC WATERS

by

G. Thorsteinsson

BACKGROUND

In an ICES paper (1970/K:15), Unnur Skúladóttir reported on the shrimp (Pandalus borealis) fisheries in Iceland up to 1969.[1] Since the above-mentioned paper appeared, new shrimp grounds have been discovered off the southwest coast of Iceland, where an important fishery has now developed.

The by-catch of undersized cod and haddock has been a serious problem in some years in two of these fishing areas, i.e., in Isafjarðardjúp and in Miðnessjór off the southwest coast. Isafjarðardjúp has been shrimped longest (for 37 years). The by-catch of undersized whitefish has only become a serious problem in the last 6 to 7 years at times when spawning had been successful. This is because the trawls have increased in size and towing has been accelerated. The length of the belly of the trawl seems also to be an important factor. The older, extremely short trawls could not be towed faster than approximately 1 knot since greater speed resulted in backflow in the net and thereby decrease in catch.

The grounds in Miðnessjór have only been fished for 3 years. Great quantities of small haddock ("0"-group and "1"-group) inhabit these grounds from autumn (September/October) to spring (May), so shrimping is prohibited during this period, making the season rather short.

At present, no types of selective shrimp trawls are in use in Iceland nor will they probably be used in the future. There are two main reasons for this:

(1) In Isafjarðardjúp the grounds are so extensive and of such varying depth that small fish have never been observed in the whole area simultaneously. Thus, shrimpers can always continue fishing in some parts of the grounds.

(2) The amount of young haddock is so great in Miðnessjór in autumn and winter that no selective trawls can be used without the risk of catching considerable quantities of young fish. Moreover, intensive fishing in a short season seems to provide optimum utilization of the shrimp stock.

Here follows a brief report on trials with selective shrimp trawls in Icelandic waters.

DOUBLE CODEND TRAWLS

Encouraged by a paper by G. Kurc presented at the FAO Conference on Fish Behaviour in Relation to Fishing Gear, held in Bergen in 1967, the Marine Research Institute started fishing trials with a double codend trawl in December 1969 and further trials were made in 1970. At the beginning of the trials in December 1969 a few comparative tows were made on the regular shrimp grounds in Isafjarðardjúp. The experimental selective trawl (Fig. 1) proved to catch similar quantities of shrimp as conventional trawls. An accurate comparison could not be made since the research vessel operating the experimental trawl has 250 BRT versus the 10 to 20 BRT of the commercial vessels. However, the small vessels had the advantage of the skippers' experience and knowledge of the grounds. After that satisfactory start, search for new shrimp grounds took place off the north coast. Two shrimp grounds, west of Kolbeinsey and east of Grímsey, were discovered and here shrimp catches of 100 to 230 kg/h were taken. Since the trials did not take place on commercial shrimp grounds,

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1/ This paper, "The Deep-Sea Fisheries in Icelandic Waters", was handed out at the meeting for information.

for lack of commercial boats, the comparative efficiency of the gear could not be assessed. The lower codend was covered with netting of small meshsize in order to determine if and how much of the shrimp catch escapes through the lower codend. After some experiments with lead ballast on the separating panel, satisfactory results were obtained since only 0 to 10 percent of the shrimp "escaped". As the seabed was very soft on these grounds, the lower codend sometimes had to be left open to prevent it from filling with mud. Since fish was scant on these grounds, the selective effect of the gear could not be tested on this cruise.

Encouraged by the result of these experiments, a double codend selective trawl was tested in the Nephrops fishery off the southwest coast in the summer of 1970. The purpose of the cruise was to catch Nephrops in the conventional manner and at the same time take shrimp in the upper codend, as shrimp had been observed on some Nephrops grounds. This experiment failed for several reasons. The small meshes of the greatest part of the net caused increased towing resistance, resulting in Nephrops catches below commercial level. The trawl, on the other hand, did not catch sufficient quantities of shrimp even in places where Nephrops catches were poor. This could be explained by the fact that the wings of the Nephrops trawls are rigged of very stretched netting, which might cause the shrimp to jump back over the leadline. The behaviour of the shrimp was found to be quite different from that described above, since 24 percent of the shrimp was caught in the lower codend against as much as 77 percent being found in the lower codend when using the original gear. This difference in behaviour could be related to the condition of the seabed which, in the latter experiment, was much harder than in the former.

After these negative results, no further experiments were made with this type of gear. However, in order to gain further knowledge of the grounds off the north coast described above, the double codend trawl was tested again on these grounds in late 1970 against a 39-m shrimp trawl of conventional type (Fig. 4). The catches were now poorer, on average 84 kg/h in the big trawl against 30 kg/h with the selective trawl. No significant difference in shrimp size could be observed in the two types of gear.

The selective effect of the gear varied with regard to both fish length and also species, as different tows sometimes yielded quite a variable composition. This was particularly true in the case of small haddock. From 15 to 89 percent of the 11 to 15 cm length group of this species was found in the upper codend. The results for some other species are shown in the following table.

TABLE 1

Double codend trawl (percentage of fish in upper codend)

Size groups (cm)	cod	rough dab	redfish	Gadus esmarki
11-15		17	27	
16-20	31	12	7	95
21-25	20	4	10	
26-30	8	4		
31-35	3	1		

AMERICAN-TYPE SELECTIVE SHRIMP TRAWL

In order to avoid catching small haddock on the shrimp grounds in Miðnessjór, the American-type selective trawl was rigged in March 1971. The trawl was made in accordance with the right-hand side drawing (Fig. 2) in Unnur Skúladóttir's paper. However, the wings were made deeper, as shown in Fig. 2 and the belly pieces were made equal. The shape of the separating net panel is shown in Fig. 3. Other characteristics of the gear were as follows:

Flotation: On each wing 12.6 l, on bosom 7.2 l; during trials 3 floats (17.5 cm) added;

Groundrope weight: Lead on each wing 14.8 kg, on bosom 13.8 kg; additionally 4 chains of 7 kg each on both wingends and quarter corners;

Length of headline, centre line and fishing line: 28.2 m;

Sweeplines: 22 m long, triple.

Before this trawl was tested on the shrimp grounds, it was inspected by divers in shallow water (25 to 32 m). Unfortunately, no photographs could be taken due to failure of the camera. The divers, however, reported that the meshes of the separating netting panels were quite open (almost 90° angles) and that the escape gaps were functioning well, forming a narrow ellipse with a horizontal width of about 30 cm. The netting of the wings and the separating panel only touched in a small area close to headline and fishing line. The net opening height measured 2.1 m.

After that, the trawl was tested in the second half of April on the shrimp ground in Miðnessjór. Early in the experiment, a 6 m-long square was mounted on the net without any change in the separating net panel.

Thus the headline became shorter (17.5 m), but the older headline remained and most of the floats were transferred to the new headline.

When the experiments were taking place, large quantities of spawning cod migrated to the shrimp grounds. This resulted in decreased shrimp catches which, moreover, were quite variable from one tow to another. These conditions were certainly most unfavourable for comparative fishing. However, on the average, while the experimental gear seemed to catch as much shrimp as regular trawls, it held only one fifth of the small haddock contained in the commercial catches.

It must be emphasized that these figures are derived from very few comparative tows. To determine escape rates the escape gaps were covered with bags of shrimp netting. It was found that in total 7.7 percent of the shrimp escaped, of which slightly more through the lower gap. Checking the haddock escape in the same way, the results were quite the opposite. Through the lower gap only 14 percent of the 10 to 15-cm group escaped, 18 percent of the 16 to 20-cm group and 71 percent of the 21 to 25-cm group. The only plausible explanation of this is that most of the small fish escaped over the headline and not through the gaps. The square may, therefore, hinder a fair selection. However, should the shrimp swim over the headline, it could be expected that more shrimp would escape through the upper gap, but this was not the case as only 44 percent of the total escape was through that gap.

In June, at the beginning of the summer season, further experiments were made. Two commercial boats started the season with selective trawls which were not fitted with a square. The skippers of these boats reported a catch in the selective trawls, as compared with conventional trawls, of 1:1.7 in favour of the latter. It is hardly surprising, therefore, that they did not continue to use selective trawls. Both captains reported very small quantities of small fish in the catch.

Experimenting from a research vessel in June, better results were obtained with regard to shrimp after some rigging experimentation. Using a square and covering the upper gap with 130 mm netting to retain larger fish and the lower gap with 80 mm netting to retain Nephrops - both fish and Nephrops are of considerable importance as by-catch in this fishery - the shrimp catches were approximately 30 percent below the average of the commercial shrimpers. This, however, did not impress the skippers.

Hardly any haddock are on the shrimp grounds in June, so the selective effect could only be observed on rough dab and Gadus esmarki. Only 15 rough dab specimens were caught in the selective trawl/h as compared with 294 in the 39-m trawl of conventional design.

The catches of G. esmarki were quite variable, but no selective effect could be observed with this species. The shrimp catches were almost double in the 39-m trawl as compared with the selective trawl, but this does not prove anything since the large trawl was accidentally used on days of better catching.

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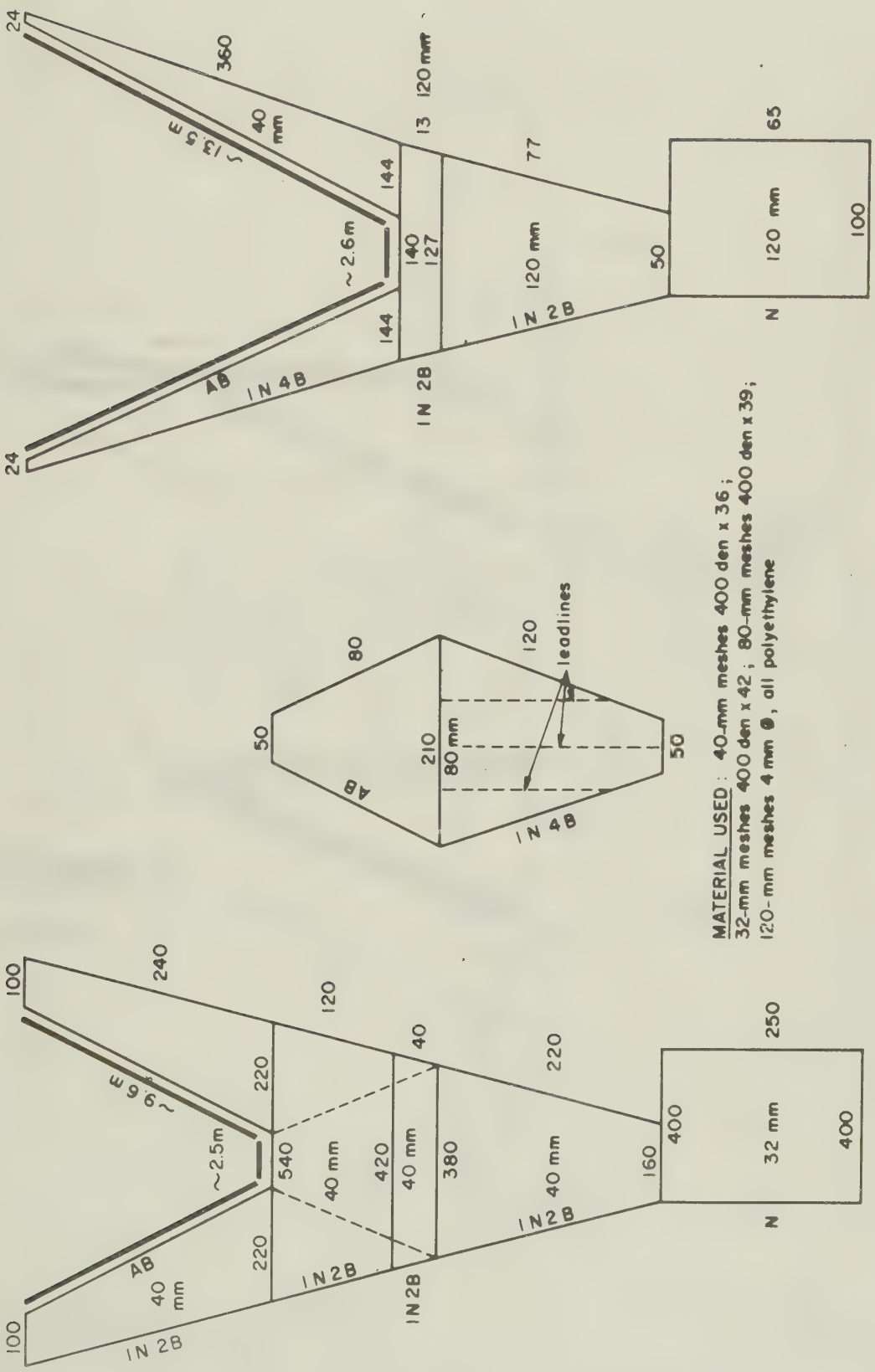


Fig. 1 The original double-codend shrimp trawl

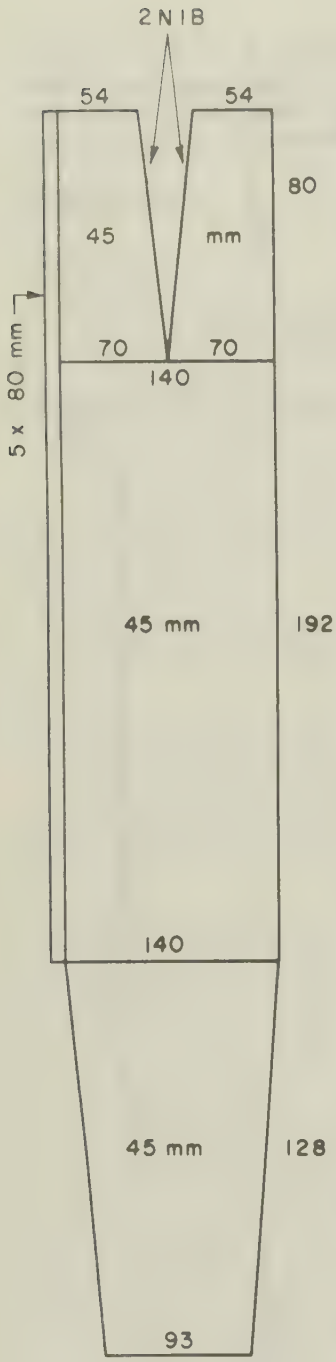


Fig. 2 A wing of the selective trawl (Polyethylene 23 tex x 24)

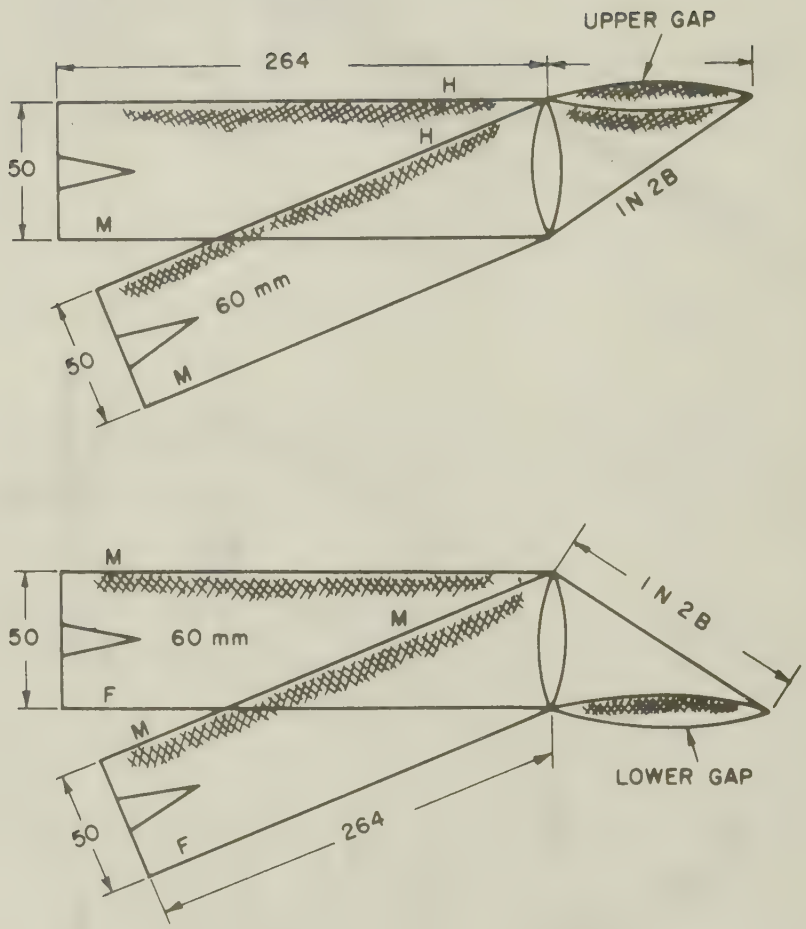


Fig. 3 Separating panels of the American type selective trawl

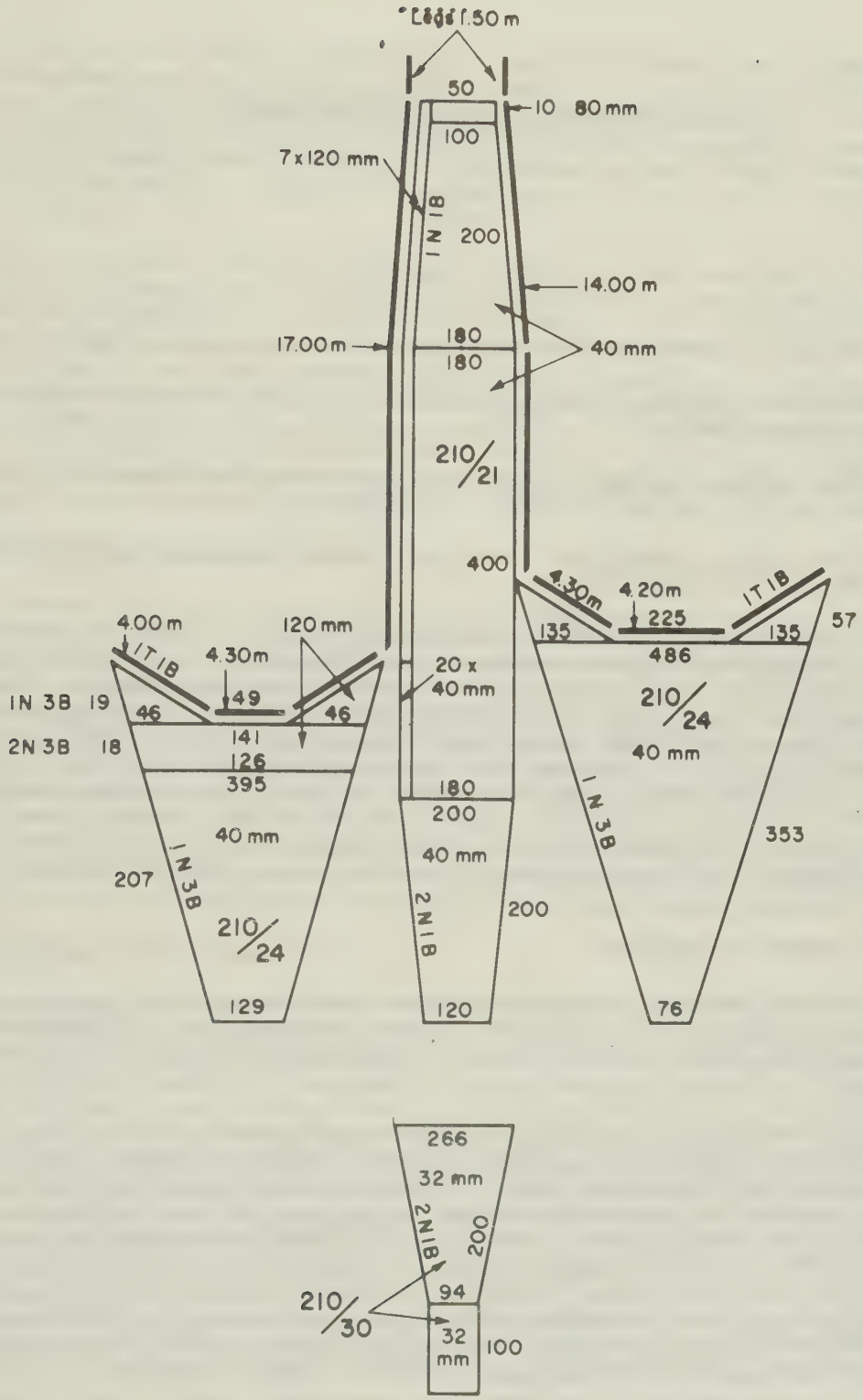


Fig. 4 Icelandic 39 m shrimp trawl of conventional design

ENGLISH TRIALS OF THE DUTCH ROTARY SIEVE

by

P. Warren

INTRODUCTION

In England and Wales, commercial shrimp fishing is concerned mainly with three species:

The deepwater shrimp, Pandalus borealis is restricted to the area of the Farn Deeps off the northeast coast of England.

The pink shrimp Pandalus montagui is also found around the Farn Deeps but it is more widely distributed, and the important fishery is in the Wash.

The brown shrimp Crangon crangon has a much more general distribution, but fishing is concentrated in the Wash and Morecambe Bay.

In both these latter areas, shrimp is still sorted by hand on board the catching vessels; mortalities of all shrimp and fish are considerable and the quality and size of shrimp sent to market are subject to seasonal fluctuation. As a possible solution to the problems of conservation and quality control, the rotary shrimp sieve produced in Holland provides an attractive alternative to traditional English handling methods. During 1972/73 a rotary sieve was demonstrated to English fishermen and trials were conducted to assess its performance. These trials were begun using brown shrimp for which the sieve was designed, and were later extended to include both Pandalid species which had not previously been sorted by the sieve. The results of commercial trials have been prepared in leaflet form for English fishermen and merchants. This paper reports the results of some observations made during this work.

THE ROTARY SIEVE: METHOD OF OPERATION

The rotary sieve is designed to separate species from a mixed trawl catch into three size categories on the basis of body thickness. These categories are: (a) "consumption" or market shrimp; (b) brood shrimp and tiny fish; (c) larger species, (fish, crabs, starfish, etc.) and debris.

To achieve this sorting, two concentric cylinders are rotated at 10 to 16 rpm; a larger "mesh" cylinder inside a second smaller "mesh" cylinder. When mixed catch is introduced into the inner cylinder, all shrimp and small fish quickly fall through the "meshes" of that cylinder. Larger species and debris are retained in the inner cylinder and may be returned to the sea. Once in the outer cylinder, shrimp are separated into "large" and "small" on the basis of their body thickness. Market shrimp are retained and fed into a box or basket; small shrimp and tiny fish pass between the rodsof the outer cylinder and may also be returned live to the sea. Seawater pumped into the sieve increases its efficiency, and ensures that market shrimp are thoroughly cleansed. Small shrimp and fish are returned to the fishery in a flow of water which helps to minimize physical damage.

Crangon crangon: SIEVING AND SURVIVAL

The trials of the rotary sieve's performance were begun on stocks of C. crangon in the Thames estuary and the Wash. As was anticipated, the rotary sieve was most effective at sorting brown shrimp from mixtures of trawl-caught material in both areas. At the time of the Wash trials, brood shrimp were abundant but the sieve returned them to the sea below a well defined minimum size. The minimum size of market shrimp retained by the sieve was

found to be about 50 mm (total length) having a weight of about 1.25 g. Fig. 1 shows the frequency distributions by length and weight of samples of C. crangon retained by the rotary sieve. In Boddeke's report of the rotary sieve trials in Holland (Visserij, Jan. 1971) he graded market (consumption) shrimp according to the number present in one kg. The quoted number/kg ranged from 552 to 596. In the Thames estuary trials, there were 528 to 539/kg, but in the Wash they improved to an average of 407/kg. Small reject shrimp numbered 1 320 to 1 870/kg.

The results of these trials with Crangon established that very few large shrimp were rejected by the sieve and that a very high proportion of those small shrimp returned to the sea were alive immediately after sieving. To obtain a better indication of shrimp mortalities, random samples of small brown shrimp were taken from 30 min trawl tows, sieved, and then retained for one day's observation in tanks of seawater. Providing the shrimp were handled with reasonable care it was found that nearly 100 percent were alive after one day and might be expected to live when returned to the sea. However, when brown shrimp were taken from two and three-hour trawl tows, survival rates were much lower, demonstrating clearly that shrimp mortalities were likely to result from damage sustained before sieving, rather than to the use of the sieve itself.

FISH BY-CATCH: SIEVING AND SURVIVAL

It is normal for brown shrimp trawling to take many small flatfish as a by-catch and conservation of these fish is a major design feature of the rotary sieve. In the Wash trials (July 1972), up to 2 000 small fish of various species were taken in 30 min with a 4-m beam trawl. Once again, the sieve was effective in separating these fish from market shrimp, and random counts suggested that 95 percent of trawl-caught fish could be returned to the fishery. To obtain an assessment of fish mortalities after sieving, samples were retained for one day's observation in tanks. With reasonable handling, it was possible to keep alive 80 to 100 percent of soles of between 5 and 15 cm total length.

The survival rates of small plaice, dabs, skate and flounders were found to vary between 50 and 90 percent after one day. Mortalities among small fish appeared to relate mainly to the extent of trawl damage and longer tows caused higher mortality.

Pandalus montagui: SIEVING AND SURVIVAL

The P. montagui population in the Wash has a structure based upon two year classes and fishing is concerned with shrimp of group "1". Sieve trials were carried out in July-August when shrimp of group "0" were first appearing in the commercial catches, and a length/frequency distribution of the population is presented in Fig. 2a. After sieving, the minimum carapace length of market shrimp was approximately 11 to 12 mm (dotted line, Fig. 2a); shrimp of group "0" and some smaller individuals of group "1" were returned to the sea. The weight-frequency distribution of a sample of shrimp retained by the sieve is shown in Fig. 2b. It may be seen that at 1.2 g, the minimum weight of market P. montagui, is closely similar to that for C. crangon. Market pink shrimp were in the range of 385 to 418/kg and it is likely that this count would decrease later in the year as shrimp continued to grow. Rejected shrimp were in the 660 to 770/kg range.

Compared with Crangon it is relatively much more difficult to keep P. montagui alive; 30-min air exposure at summer temperatures will kill most pink shrimp. Commercial trawl tows are normally of 1 to 3 h duration and the mixed catch from these long tows takes correspondingly long to sort. Therefore, as a result of trawl damage and air exposure, pink shrimp mortalities are normally very high in this fishery and conservation is therefore difficult. However, with careful handling, it was possible to take shrimp from 30-min trawl tows and after sieving to achieve survival rates after one day in tanks of 30 percent among large, and 90 percent among small shrimp. While the conservation of pink shrimp may pose considerable problems, there can be no doubt that rotary sieving is a more rapid method of sorting the catch. It was found that market shrimp were graded more evenly and were of improved appearance when compared with those sorted by traditional hand methods.

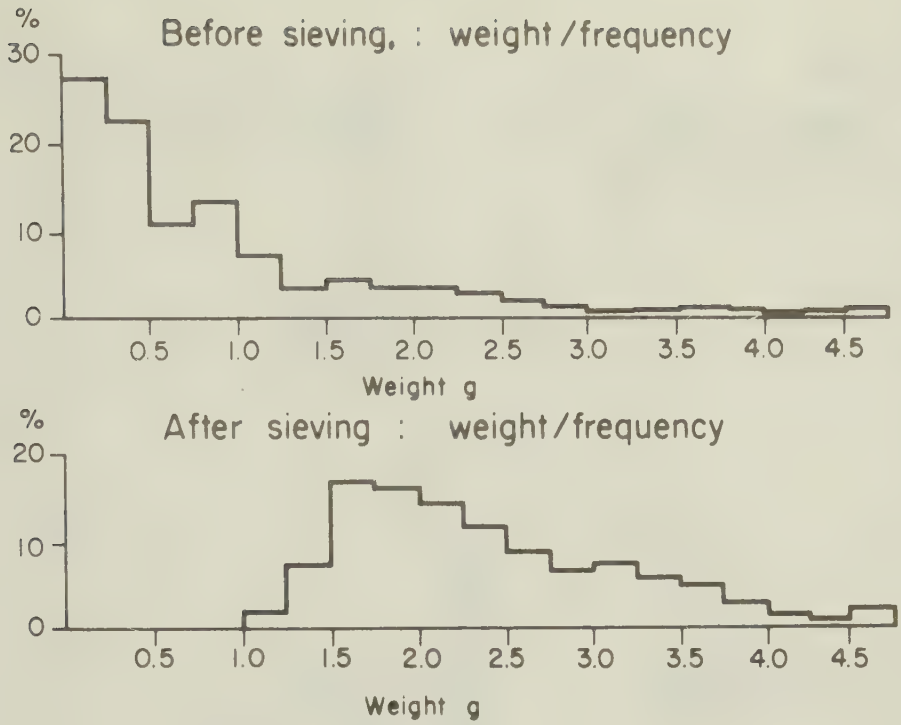
Pandalus borealis: SIEVING AND SURVIVAL

Since 1966, the population of P. borealis around the Farn Deeps has undergone considerable fluctuations in abundance, and shrimp fishing has therefore been sporadic. However, the area supports a fleet of vessels trawling for Nephrops and various fish species. A constant feature of this fishery is the abundance of undersize whitefish by-catch, and when sieve trials were extended to P. borealis in the Farn Deeps, the composition of the catch was very different from that found further south. Because species separation is based upon body thickness, Nephrops were not selected by the action of the sieve and they were removed from the catch by hand before or after sieving. Large cod, haddock and flatfish species were removed by the same method.

Invariably, trawl catches contained relatively small volumes of shrimp among much larger volumes of small whitefish. It was useful to reduce the quantity of material for sieving by separating shrimp and fish in the trawl before the codend was brought aboard. This was done by raising the codend sufficiently to clip on a weight and lowering the net back into the water. After 5 to 10 minutes, a significant improvement in shrimp concentration was possible as shrimp sank to the bottom of the codend and whitefish floated to the water surface. The codend was then divided with a rope strop and the first lift contained a majority of the shrimp. This catch mixture was sorted with the rotary sieve.

The P. borealis population is composed of three year classes and commercial interest is directed toward shrimp of groups "1" and "2". Shrimp of group "0" and broken fragments of larger shrimp were rejected by the sieve and returned to the sea. In addition to discarding small shrimp, a few of the largest shrimp of group "2" were also rejected by the sieving process. Most of these large shrimp were berried females and subsequent measurements showed that the presence of an egg mass had increased their body thickness to the point where it equalled or exceeded the "mesh" size of the inner cylinder. This was not a serious problem because it was convenient to position a member of the crew at the output end of the sieve to pick out passing Nephrops, and large shrimp could easily be removed at the same time. However, it would be valuable to repeat the observations after the eggs have hatched. The carapace length/frequency distribution of a random sample of P. borealis, the size of rejected small shrimp and of rejected large shrimp are shown in Fig. 3. The minimum size of P. borealis retained by the sieve was about 12 mm carapace length, and was similar to that of P. montagui. Of the larger rejects, most had carapace lengths greater than 18 mm.

In these trials, whitefish below a total length of 15 cm were retained with the shrimp catch, and sprats were prominent in this size category. If necessary, these small whitefish could be separated by flotation in seawater but it was quicker to remove sprat by hand-picking. Having been trawled at a depth of 75 to 90 m, mortalities among by-catch whitefish approached 100 percent and few shrimp remained alive after commercial trawl tows lasting up to 4 hours, so the introduction of rotary sieving in this area would not aid the conservation of young fish. This is no reflection upon the performance of the sieve, the limitations of which in the Farn Deeps fishery were not difficult to anticipate. The design and general performance of the sieve are admirable and in other areas where there is a sufficient size differential between shrimp and their by-catch, an adjustment of the mixer cylinder "mesh" should provide a thoroughly satisfactory result. Also, with the addition of a simple elevator, available from the manufacturers to supply mixed catch to the sieve, the sorting of P. borealis, Nephrops and fish by-catch can be automated and handled by one man.



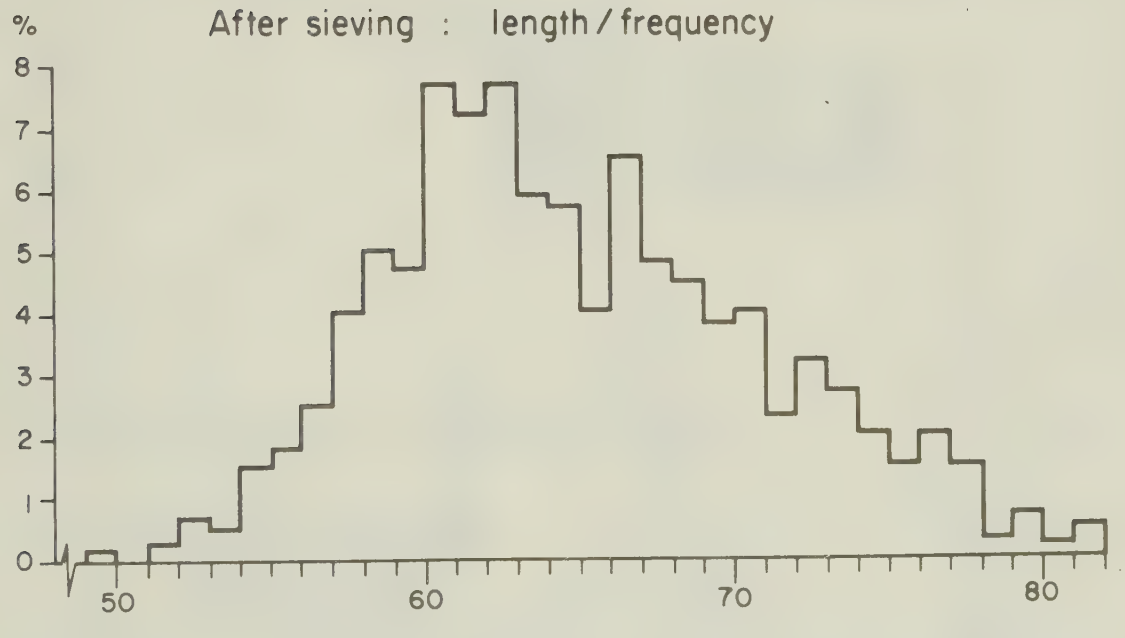


Fig. 1 - Crangon crangon

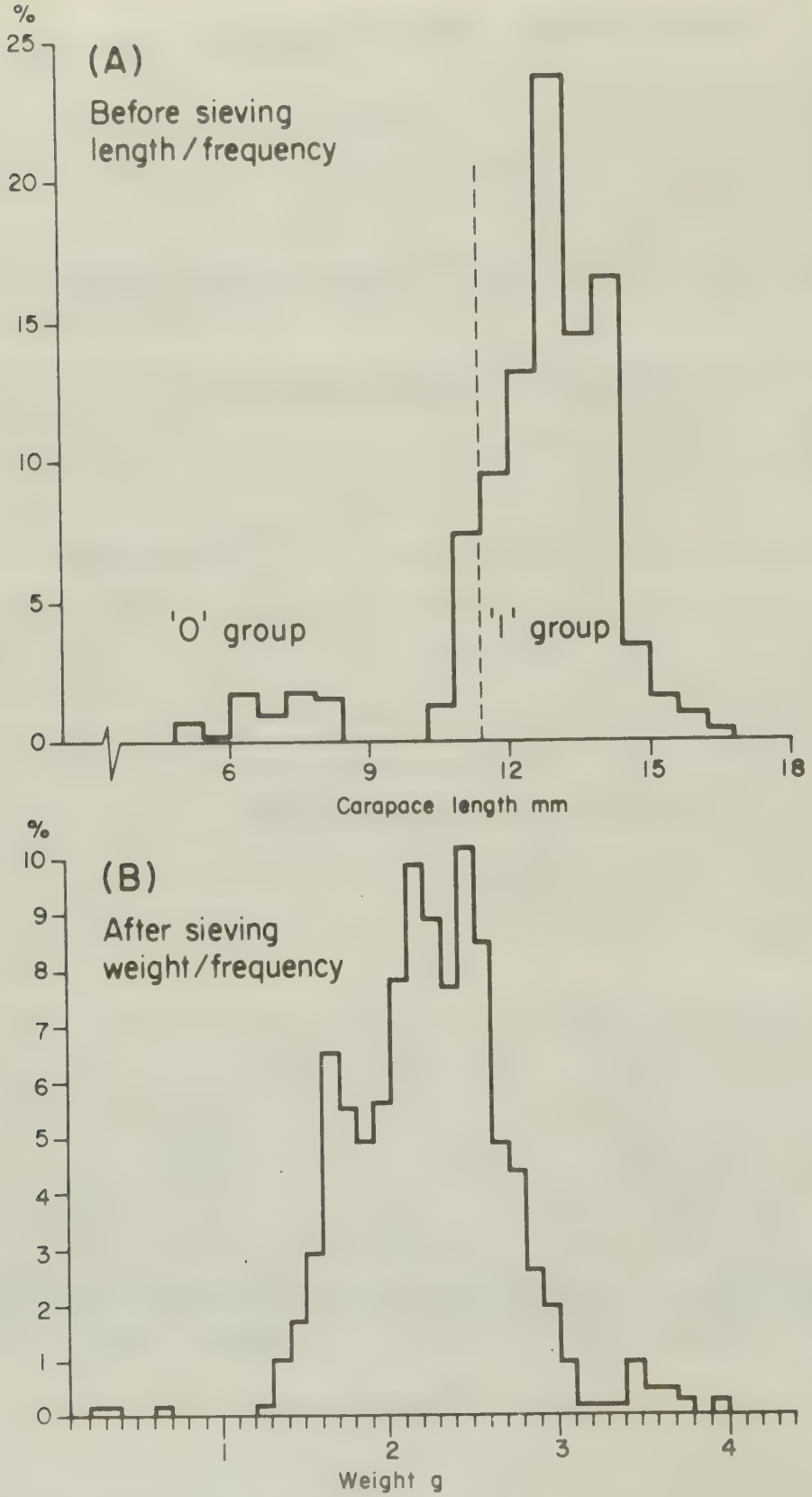


Fig. 2 Pandalus montagui

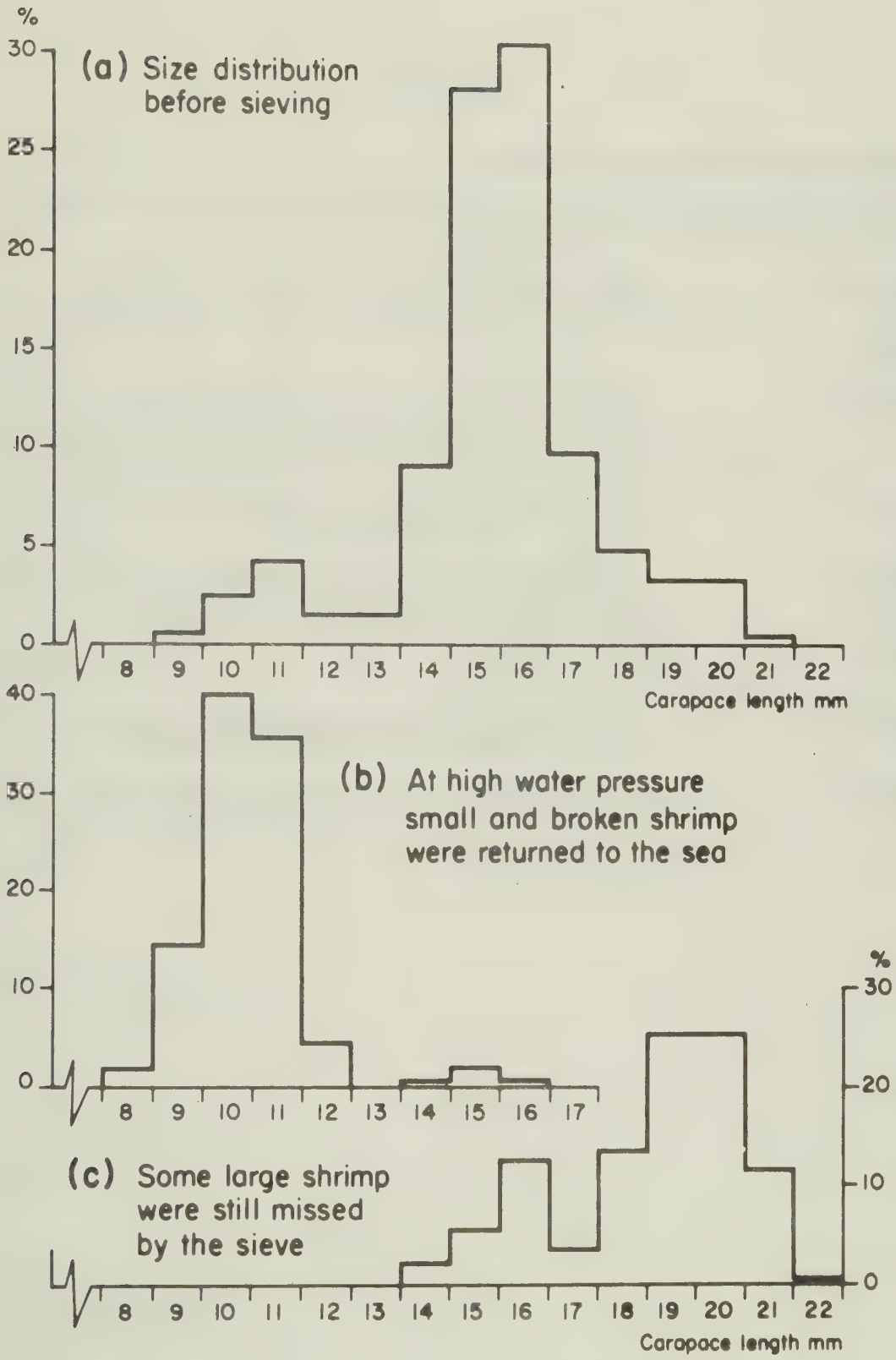


Fig. 3 Pandalus borealis

APPENDIX II

List of other relevant background material

The following papers, which are relevant to the Consultation, were brought to the meeting for the attention of the participants:

Beardsley, A.J. and High, W.L. 1970 — Shrimp sorting trawls in the Pacific Northwest. Nat. Fisherman (Camden, Me.) 50 (13):49, 51-52

Beardsley, A.J. 1973 — Design and evaluation of a sampler for measuring the near-bottom vertical distribution of pink shrimp, Pandalus jordani. NOAA; NMFS. Fishery Bulletin (Seattle, Wash.) 71 (1)

Boddeke, R. 1971 — De spoelsorteermachine voor de garnalenvisserij. Visserij ('s-Gravenhage) (1):3-11

High, L.H., Ellis, I.E. and Lusz, L.D. 1969 — A progress report on the development of a shrimp trawl to separate shrimp from fish and bottom-dwelling animals. Commer. Fish. Rev. (Wash. D.C.) 31 (3):20-33

Skúladóttir, U. 1970 — The deep-sea prawn (Pandalus borealis) fisheries in Icelandic waters. ICES Shellfish and Benthos Committee, K:15 (Mimeo)

Warren, P.J. 1973 — English trials of a Dutch shrimp sorting machine. Shellfish Inf. Leaflet (Burnham-on-Crouch, Essex) 29

APPENDIX III

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MR/E2835/E/11.73/1/750